

***Evaluation of Tc-99 in  
Groundwater at INTEC:  
Summary of Phase 1 Results***

**Idaho  
Completion  
Project**

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Bechtel BWXT Idaho, LLC

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## **Evaluation of Tc-99 in Groundwater at INTEC: Summary of Phase 1 Results**

**September 2004**

**Idaho Completion Project  
Idaho Falls, Idaho 83415**

**Prepared for the  
U.S. Department of Energy  
Assistant Secretary for Environmental Management  
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## **ABSTRACT**

This report summarizes the results of the Phase 1 evaluation of the radionuclide technetium-99 (Tc-99) in the Snake River Plain Aquifer underlying the Idaho Nuclear Technology and Engineering Center (INTEC). In May 2003, routine groundwater monitoring at monitor well ICPP-MON-A-230, located near the northern boundary of the INTEC, indicated that Tc-99 was present in the aquifer at concentrations approximately twice the derived maximum contaminant level for Tc-99 of 900 pCi/L. This was the first time that Tc-99 concentrations in the aquifer had been found to exceed the maximum contaminant level. The primary objective of this project was to determine the source or sources of Tc-99 to groundwater, with particular emphasis on the area surrounding monitor well ICPP-MON-A-230 in the northern portion of the INTEC. The investigation was performed in accordance with the *Supplemental Work Plan for Tc-99 Evaluation in Groundwater* (ICP/EXT-03-00029), which is a supplement to the *Monitoring System and Installation Plan for Operable Unit 3-13, Group 4, Perched Water* (DOE/ID-10774).

The results of the Phase 1 evaluation indicate that the elevated Tc-99 in groundwater at monitor well ICPP-MON-A-230 is most likely derived from historical liquid waste releases at the INTEC tank farm, including the CPP-28 and CPP-31 releases. The most likely mechanism for transport of Tc-99 to the aquifer is downward movement of contaminated water through the vadose zone to the water table. Tc-99 has been present in the aquifer beneath the northern portion of the INTEC since at least as early as 1995.



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## ACRONYMS

ARAR	applicable and relevant or appropriate requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFA	Central Facilities Area
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
K <sub>d</sub>	soil-water distribution coefficient
MCL	maximum contaminant level
MWTS	Monitoring Well and Tracer Study
OU	operable unit
PEW	Process Equipment Waste (evaporator)
R <sub>f</sub>	retardation factor
RI/BRA	remedial investigation/baseline risk assessment
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SNF	spent nuclear fuel
SRPA	Snake River Plain Aquifer
Tc-99	technetium-99
USGS	United States Geological Survey
WAG	waste area group



# **Evaluation of Tc-99 in Groundwater at INTEC: Summary of Phase 1 Results**

## **1. INTRODUCTION**

This report summarizes the results of the Phase 1 evaluation of the radionuclide technetium-99 (Tc-99) in the Snake River Plain Aquifer (SRPA) underlying the Idaho Nuclear Technology and Engineering Center (INTEC). In May 2003, routine groundwater monitoring at new monitor well ICPP-MON-A-230, located near the northern boundary of INTEC, indicated that Tc-99 was present in the aquifer at concentrations approximately twice the Tc-99 derived drinking water standard of 900 pCi/L. Reported Tc-99 concentrations in the May 2003 groundwater samples from ICPP-MON-A-230 were  $2,220 \pm 37.7$  pCi/L for the primary sample and  $2,110 \pm 32.4$  pCi/L for a duplicate sample. This was the first time that Tc-99 concentrations in the aquifer had been found to exceed the drinking water maximum contaminant level (MCL). The primary objective of this project was to determine the source or sources of Tc-99 to groundwater, with particular emphasis on the area surrounding monitor well ICPP-MON-A-230 in the northern portion of INTEC.



## **2. BACKGROUND**

The following sections provide a brief overview of the occurrence of Tc-99, its behavior in soil and groundwater, and the results of historical monitoring of Tc-99 in groundwater at the Idaho National Engineering and Environmental Laboratory (INEEL).

### **2.1 Occurrence of Tc-99 in Spent Nuclear Fuel**

Tc-99 is a long-lived radionuclide produced primarily as a fission product in nuclear fuel. The half-life of Tc-99 is approximately 213,000 years, and it decays to stable Ru-99 by beta emission. The relatively long half-life of Tc-99 results in much lower radioactivity per gram compared to other fission products, such as Cs-137 or Sr-90; but Tc-99 nevertheless exhibits radioactivity significantly greater than natural uranium. The specific activity of Tc-99 is 0.0169 Ci/g (DOE-ID 2000).

Although numerous other radioactive isotopes of technetium are known, only Tc-99 is produced in appreciable quantities in nuclear reactors. Fission yields of Tc-99 in nuclear reactors are approximately 6.1% from fission of U-235 and 5.9% from fission of Pu-239 (Rard et al. 1999). The fission yield of Tc-99 is similar to that of Cs-137, indicating that the initial molar concentrations of these two radionuclides are approximately the same in spent nuclear fuel (SNF). Because of its much longer half-life, however, the activity of Tc-99 in SNF is lower than that of Cs-137 by a factor of about 10,000 (Wenzel 2002). Approximately 1 kg of Tc-99 is produced per ton of uranium fuel (3% enriched) after burnup (Chen, Burns, and Ewing 2000). It is estimated that several tons of Tc-99 are produced annually in nuclear reactors worldwide (Rard et al. 1999).

As of July 1999, the total amount of Tc-99 present in the INTEC wastes was estimated as 3,680 Ci (Swenson 2003), which equates to a mass of about 218 kg Tc. This includes approximately 3,450 Ci in the calcine waste, 224 Ci in the remaining liquid and solid wastes in the INTEC tank farm, and 6 Ci that were shipped off-Site. The small amount of Tc-99 that may have been released to groundwater has not been quantified but is believed to be, at most, a fraction of 1% of the total quantity of Tc-99 in the SNF reprocessed at INTEC.<sup>a</sup> Section 3.9 provides details supporting this statement.

In addition to its production during nuclear fission, Tc-99 may also be produced as a neutron activation product of stable Mo-98; however, this source is generally insignificant in nuclear fuels compared to its abundance as a fission product. As a result of past aboveground testing of nuclear weapons, Tc-99 is also present in precipitation, but at very low concentrations (<<1 pCi/L) (Turcotte 1982; Ehrhardt and Attrep 1978).

### **2.2 Environmental Behavior of Tc-99**

The chemistry of technetium is complex because it can exist in many different oxidation states. However, Tc exists primarily in the +7 oxidation state under the strongly oxidizing conditions present during SNF dissolution with the two predominant species being pertechnetic acid ( $\text{HTcO}_4$ ) and the pertechnetate anion ( $\text{TcO}_4^-$ ).<sup>b</sup> Similar to ruthenium and iodine, technetium can volatilize under some conditions, such as when concentrated nitric acid solutions containing Tc-99 are evaporated to dryness (Darab and Smith 1996).

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a. Swenson, M. C., 2003, personal communication with J. Forbes, December 2, 2003.

b. Thomas, T. R., INEEL, to M. C. Swenson, INEEL, October 20, 2003, "Volatility of technetium from process evaporator and calciner operations."

Under environmental conditions, by far the most common aqueous species of technetium is the pertechnetate oxyanion ( $TcO_4^-$ ) (Rard et al. 1999), the exception being strongly reducing conditions, where technetium may be reduced to the +4 oxidation state (Krupka and Serne 2002). Oxidizing conditions generally prevail in soil and groundwater beneath INTEC; therefore, any Tc-99 present is expected to exist almost entirely as pertechnetate anion.

Numerous studies have demonstrated that Tc-99 remains highly soluble and mobile in soil and groundwater. This is attributable to the high water solubility of most pertechnetate salts and to the fact that the pertechnetate anion does not appreciably adsorb to soil surfaces under most subsurface conditions. Thus, Tc-99 is considered highly mobile in the subsurface, being similar in this regard to tritium and I-129. Krupka and Serne (2002) report that soil-water distribution coefficients ( $K_d$ ) for Tc-99 in low organic carbon soils range from 0 to 0.5 mL/g, with most values less than 0.1 mL/g. This indicates little if any sorption of Tc-99 onto soils; therefore, little or no retardation of Tc-99 occurs during groundwater transport. A laboratory study using water-saturated columns filled with INTEC alluvium, interbed sediment, and crushed basalt showed no retardation of pertechnetate ( $R_f = 1$ ) (Del Debbio and Thomas 1989). This is consistent with the results of other laboratory studies that demonstrate that Tc-99 behaves as a “conservative” solute, traveling at essentially the same velocity as the soil water or groundwater.

The drinking water MCL for Tc-99 is 900 pCi/L. This value is a derived concentration assuming Tc-99 is the only beta-emitting radionuclide present and assuming a 4-mrem/yr dose rate (EPA 2000). While drinking water standards do not technically apply to groundwater in the aquifer, the State of Idaho has adopted groundwater quality standards that are numerically equivalent to the MCLs (IDAPA 58.01.11). Furthermore, federal MCLs are considered applicable and relevant or appropriate requirements (ARARs) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Therefore, in this report, *MCL* is used as a shorthand for referring to the Idaho groundwater quality standards.

## 2.3 Tc-99 in the Snake River Plain Aquifer

Groundwater samples collected at INEEL in 1991-92 by the U.S. Geological Survey (USGS) were the first to be analyzed for Tc-99, and the results are reported in Beasley et al. (1998). Based on sampling of approximately 46 wells, Beasley et al. (1998) showed that Tc-99 was present in groundwater of the SRPA at relatively low concentrations (<60 pCi/L) over a large area extending south from the INTEC. The dilute plume containing detectable Tc-99 concentrations in groundwater was shown to extend south from INTEC to the area of Big Southern Butte, located just outside the INEEL southern boundary. The observed Tc-99 plume was similar in shape and size to the known tritium plume south of INTEC. The highest Tc-99 concentration observed at that time was 55.6 pCi/L in perched water well USGS-50. Based on the geometry of the observed Tc-99 plume, Beasley et al. (1998) estimated that a total of approximately 15 Ci of Tc-99 were present in the SRPA and that the Tc-99 plume occupied an area of approximately 53 mi<sup>2</sup>. Although no records for disposal or release of Tc-99 are known to exist, Beasley et al. (1998) attributed the presence of Tc-99 in the SRPA to its disposal at the former INTEC injection well, which was used from 1953 until 1986 for disposal of low-level radioactive wastewater (service waste) from INTEC operations. Because of the failure of the injection well casing in approximately 1968, it should be noted that service wastewater was also released into the vadose zone for several years (DOE-ID 2004a).

The Operable Unit (OU) 3-13 Remedial Investigation/Baseline Risk Assessment (RI/BRA) (DOE-ID 1997) and the OU 3-13 Record of Decision (ROD) (DOE-ID 1999) both discussed the occurrence of Tc-99 in groundwater at and downgradient of INTEC. The INTEC tank farm has stored wastes that contained Tc-99. The RI/BRA estimated that the CPP-31 liquid release that occurred in

November 1972 contained between 0.95 and 4.0 Ci Tc-99, with the average value being 2.58 Ci (DOE-ID 1997). This report further estimated that the CPP-31 release accounted for 95.9% of the Tc-99 mass released to the aquifer. The CPP-31 release site is located adjacent to the underground tanks at the INTEC tank farm.

Tc-99 concentrations in groundwater during 2001 and 2003 were presented in two annual INTEC well monitoring reports (DOE-ID 2002, 2003a). Figure 2-1 shows the locations of monitor wells at and near INTEC, and Figure 2-2 shows the Tc-99 groundwater plume present in 2001.

Prior to 2003, groundwater samples had not exceeded the Tc-99 drinking water MCL of 900 pCi/L. The maximum Tc-99 concentration observed in the aquifer prior to 2003 was 518 pCi/L, reported in a sample collected December 1994 from aquifer monitor well MW-18-4 (DOE-ID 2003a). Monitor well MW-18-4 is located in the central part of INTEC and southeast of the INTEC tank farm (Figure 2-1). During groundwater monitoring in 2001, the highest observed Tc-99 concentration was in aquifer monitor well USGS-52 located along the eastern INTEC fence line (Figure 2-1); this well contained 322 pCi/L of Tc-99. Perched water samples have also been analyzed for Tc-99, but none have exceeded the MCL of 900 pCi/L. The highest Tc-99 level reported historically in perched water was  $736 \pm 6$  pCi/L for a sample collected in June 1995 from deep perched monitor well MW-18-1 (DOE-ID 2003b). The highest Tc-99 concentration observed in the shallow perched water was  $592 \pm 3$  pCi/L in September 1994 at MW-10-2 (DOE-ID 2003b). Both of these perched monitor wells are located southeast of the INTEC tank farm (Figure 2-1).

During routine groundwater monitoring on May 13, 2003, the Tc-99 results for new monitor well ICPP-MON-A-230 indicated a higher concentration than had been observed previously in any other well. This monitor well is located within the INTEC security fence and approximately 300 ft outside the tank farm northern fence line (Figure 2-1). The well is screened from 443 to 483 ft with a pump intake depth at 474 ft below land surface. Depth to water prior to sample collection was 463.2 ft below the measuring point or approximately 460 ft below ground surface (bgs). The laboratory reported a Tc-99 concentration of  $2,220 \pm 37.7$  pCi/L for a groundwater sample collected May 13, 2003, from this well. This result was the first to exceed the Tc-99 groundwater quality standard of 900 pCi/L. Because the well had not been sampled prior to May 2003, no previous groundwater quality results were available. In contrast to the Tc-99 results, concentrations of tritium ( $3,700 \pm 178$  pCi/L), Sr-90 ( $7.61 \pm 1.05$  pCi/L), and I-129 ( $0.12 \pm 0.03$  pCi/L) in the May 2003 groundwater sample from ICPP-MON-A-230 were below their respective MCLs and were similar to the concentrations observed in other INTEC monitor wells. Figure 2-3 shows the distribution of Tc-99 in the aquifer as reported in the 2003 Annual Well Monitoring Report (DOE-ID 2003a).

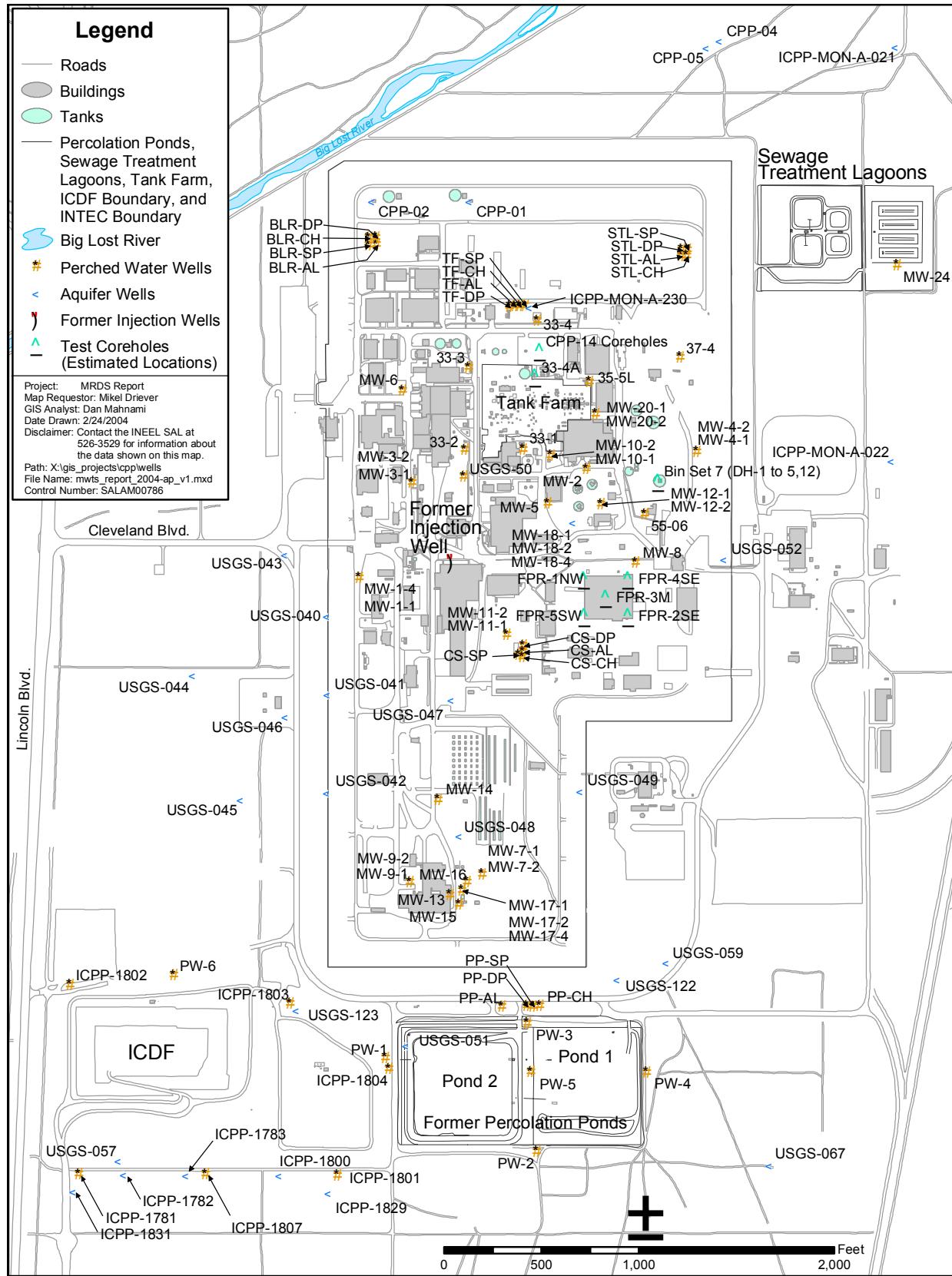
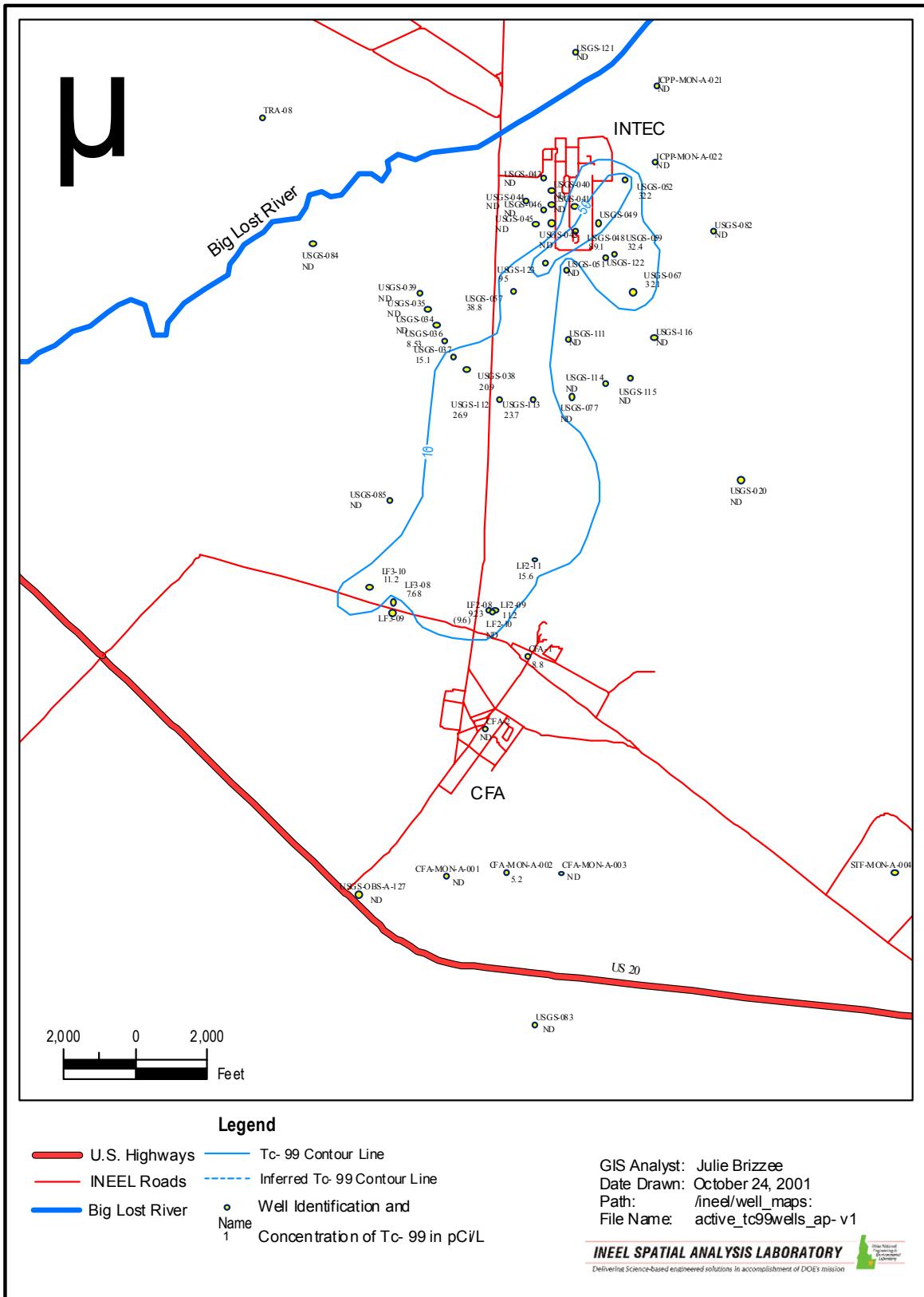


Figure 2-1. INTEC well locations.



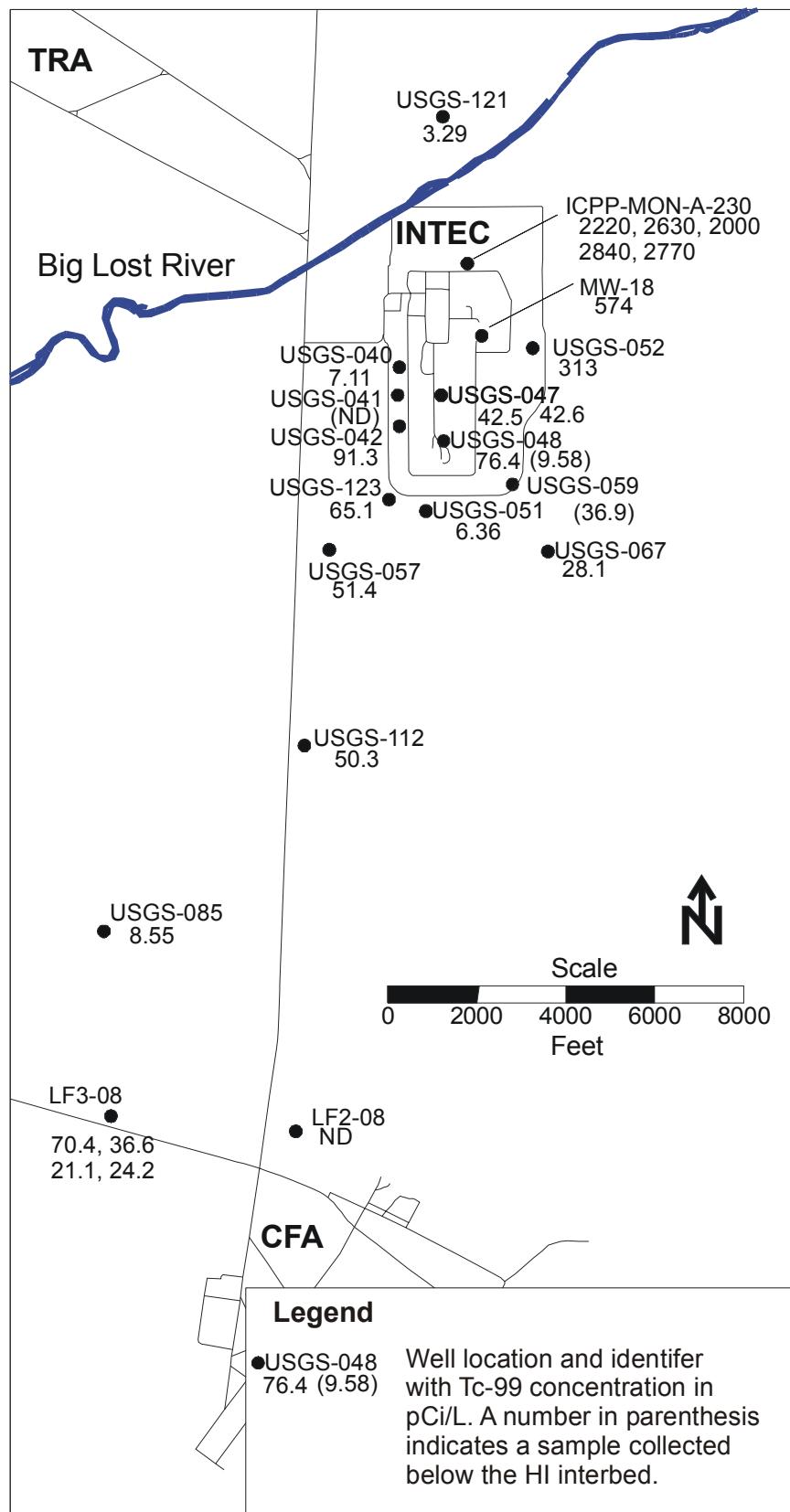


Figure 2-3. Distribution of Tc-99 in the SRPA in 2003 (concentrations in pCi/L, Source: DOE-ID 2003a).

### **3. EVALUATION OF TC-99 AT INTEC**

As a result of the elevated Tc-99 concentration reported for the May 13, 2003, groundwater sample from monitor well ICPP-MON-A-230, an investigation was performed to assess the reasons for this unexpectedly high concentration. The investigation was performed in accordance with the *Supplemental Work Plan for Tc-99 Evaluation in Groundwater* (ICP 2003); this Work Plan is a supplement to the *Monitoring System and Installation Plan for Operable Unit 3-13, Group 4, Perched Water Well Installation* (DOE-ID 2003c). A phased approach was used, with the primary objective of Phase 1 to evaluate the extent of the elevated Tc-99 in the aquifer at monitor well ICPP-MON-A-230 and to assess potential source(s) of Tc-99 to the groundwater at INTEC. The Tc-99 Supplemental Work Plan was reviewed by the Department of Energy Idaho Operations Office, Environmental Protection Agency, and the Idaho Department of Environmental Quality, and the Phase 1 work was approved on October 21, 2003.

#### **3.1 Phase 1 Scope of Work**

The Phase 1 investigation was performed in accordance with the Supplemental Tc-99 Work Plan (ICP 2003) and included the following tasks:

- Perform monthly monitoring of Tc-99 concentrations and water levels at monitor well ICPP-MON-A-230 from August 2003 through January 2004 and bimonthly monitoring for tritium, Sr-90, and I-129
- Sample ICPP-MON-A-230 in October for a broad suite of analytes, including radionuclides, mercury, volatile organic compounds, and semivolatile organic compounds
- Sample production wells CPP-1 and CPP-2 in October and December for Tc-99, tritium, Sr-90, I-129
- Evaluate ICPP-MON-A-230 well construction details to assess the potential for downhole contamination
- Review and evaluate vadose zone stratigraphy in the vicinity of the INTEC tank farm to assess potential for downward transport of contaminants
- Develop well and perform step-drawdown pumping test at ICPP-MON-A-230, with collection of groundwater samples during pumping for radionuclide analysis
- Perform radiological screening and laboratory analysis of core samples from the Tank Farm Well Set for selected radionuclides
- Conduct geophysical neutron logging of ICPP-MON-A-230 to identify potential perched water zones
- Perform colloidal borescope logging of ICPP-MON-A-230 to determine groundwater flow direction and velocity in the well
- Perform computer capture zone analysis of the INTEC raw water production wells (CPP-1 and CPP-2) and potable water wells (CPP-4 and CPP-5) to assess areal extent of well field capture zones
- Evaluate Tc-99 sources at INTEC to identify potential for groundwater contamination

- Perform laboratory analysis of archived groundwater samples from selected INTEC wells to determine past Tc-99 concentrations in the aquifer.

The following sections provide descriptions of each task along with the results.

### **3.2 Tc-99 in Groundwater at Monitor Well ICPP-MON-A-230**

To confirm the May 2003 Tc-99 results, the tank farm aquifer well was resampled on August 11, 2003, with duplicate samples from the well sent to two separate laboratories. In addition to samples collected by the INEEL contractor, the USGS co-sampled the well on the same date. The USGS sent duplicate samples from the well to two different laboratories, for a total of four laboratories analyzing groundwater samples from ICPP-MON-A-230. All of the results were consistent and indicated that Tc-99 was present in the groundwater at ICPP-MON-A-230 at a concentration in the range of 2,000 to 3,000 pCi/L (Appendix A).

Between August 2003 and January 2004, ICPP-MON-A-230 was sampled monthly to determine if the Tc-99 concentration was changing over time. The Tc-99 results for ICPP-MON-A-230 are summarized in Table 3-1 and are shown graphically in Figure 3-1. Reported Tc-99 concentrations in the groundwater samples collected at this location ranged from  $2,000 \pm 200$  pCi/L to  $2,860 \pm 49.8$  pCi/L, with a mean value of 2,557 pCi/L and standard deviation of 293 pCi/L for the 14 results (7 primary samples plus 7 field duplicates). The Tc-99 monthly sampling results appear to remain relatively constant over time, with no clear trend of increasing or decreasing Tc-99 concentration.

Analytical results for other radionuclides, inorganics, and organic compounds at ICPP-MON-A-230 are tabulated in Appendix A. Table 3-2 summarizes the results for selected constituents detected in this monitor well. Approximately half the results for Sr-90 exceeded the Sr-90 MCL of 8 pCi/L. Tritium activities were all below the MCL of 20,000 pCi/L. I-129 results were all below the derived MCL of 1 pCi/L. A gross alpha concentration of  $32.7 \pm 2.72$  pCi/L was reported for the groundwater sample collected May 13, 2003, which exceeds the gross alpha MCL of 15 pCi/L. Gross alpha values for the October 13, 2003, samples were rejected during the data validation process because the results for the sample and lab duplicate did not agree with each other. The reason for the slightly elevated gross alpha activity reported for the groundwater samples from ICPP-MON-A-230 is unknown, and the reported concentrations of individual alpha-emitting radionuclides were either very low or below detection limits. The results of the April 2004 sampling event should confirm whether gross alpha levels exceed the MCL in this well.

Gross beta results ranged up to a maximum of  $1,220 \pm 9$  pCi/L; there is no established MCL for gross beta radiation. The elevated gross beta results are consistent with the presence of elevated concentrations of Tc-99 in this well. The lack of agreement between the Tc-99 results and the gross beta results is likely attributable to the assumption implicit in the calculation of the gross beta results that all measured beta radiation is due to Sr-90 (which is used to calibrate the beta measuring instrument).

### **3.3 Monitoring of INEEL Water Supply Wells for Tc-99**

Table 3-3 summarizes Tc-99 results for potable water supply wells and drinking water at INTEC and Central Facilities Area (CFA). The INTEC drinking water distribution system draws its water from the two potable water supply wells located north of the INTEC fence line (CPP-04 and CPP-05; see Figure 2-1). In the past, routine monitoring of the INTEC drinking water supply system has not included sampling and analysis for Tc-99. As a result of the 2003 results for the tank farm aquifer well, however, testing of the INTEC drinking water system for Tc-99 was performed on August 18, 2003, and again on December 18, 2003. Tc-99 was not detected in any of the INTEC drinking water samples ( $<1.5$  pCi/L).

Table 3-1. Summary of Tc-99 concentrations in groundwater at ICPP-MON-A-230.

Well ID	Sample Date	Sample Collected By	Laboratory	Tc-99 Concentration (pCi/L)	Uncertainty (pCi/L, $\pm 1$ sigma)	MDA (pCi/L)
MON-A-230	05/13/03	INEEL	GEL	2,220	37.7	16.0
MON-A-230	05/13/03	INEEL	GEL	2,110 <sup>a</sup>	32.4	6.75
MON-A-230	08/11/03	INEEL	GEL	2,840	43.4	8.18
MON-A-230	08/11/03	INEEL	GEL	2,770 <sup>a</sup>	42.2	7.94
MON-A-230	08/11/03	INEEL	STL	2,630	260	3.0
MON-A-230	08/11/03	INEEL	STL	2,000	200	1.0
MON-A-230	08/11/03	USGS	RESL	2,340 2,290 <sup>b</sup>	10 110	NR NR
MON-A-230	08/11/03	USGS	ISU	2,417	4.3	NR
MON-A-230	09/24/03	INEEL	GEL	2,580	40.0	19.1
MON-A-230	09/24/03	INEEL	GEL	2,140 <sup>a</sup>	31.7	13.8
MON-A-230	10/13/03	INEEL	GEL	2,810	48.9	15.6
MON-A-230	10/13/03	INEEL	GEL	2,860 <sup>a</sup>	49.8	15.7
MON-A-230	10/13/03	INEEL	RESL	2,460	10	NR
MON-A-230	10/13/03	INEEL	RESL	2,350 <sup>a</sup>	10	NR
MON-A-230	11/12/03	INEEL	GEL	2,420	42.0	16.8
MON-A-230	11/12/03	INEEL	GEL	2,120 <sup>a</sup>	36.9	16.2
MON-A-230	12/16/03	INEEL	GEL	2,640	46	15.8
MON-A-230	12/16/03	INEEL	GEL	2,720 <sup>a</sup>	47.5	16.5
MON-A-230	01/07/04	INEEL	GEL	2,780	41.9	7.30
MON-A-230	01/07/04	INEEL	GEL	2,790 <sup>a</sup>	41.6	7.56

a. Field duplicate.

b. Lab duplicate (repeat analysis).

Abbreviations:

GEL = General Engineering Laboratories, Charleston, South Carolina

INEEL = Idaho National Engineering and Environmental Laboratory

ISU = Idaho State University

MDA = minimum detectable activity

NR = not reported or unknown

RESL = Radiological and Environmental Sciences Laboratory, INEEL

STL = Severn-Trent Laboratories, St. Louis, Missouri

USGS = U.S. Geological Survey

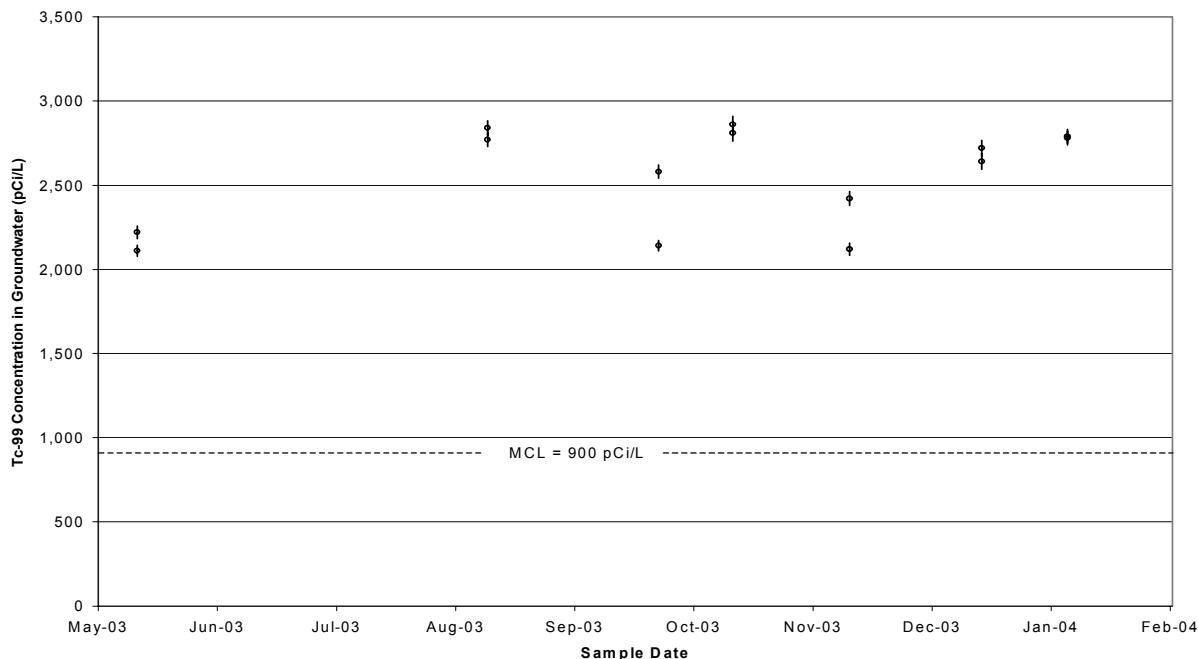


Figure 3-1. Tc-99 concentrations in monthly groundwater samples from ICPP-MON-A-230.

CFA water supply wells CFA-01 and CFA-02 have also been sampled periodically for Tc-99. Groundwater pumped from CFA-01 has consistently contained Tc-99 at very low concentrations, with a maximum of  $8.04 \pm 1.06$  pCi/L reported for a sample collected on August 20, 2002. Tc-99 has never been detected in well CFA-2. The CFA drinking water blended potable water supply had a maximum reported Tc-99 concentration of  $4.49 \pm 0.304$  pCi/L for a sample collected August 19, 2003 (Table 3-3). This trace concentration is just above the detection limit and more than 100-fold below the MCL.

In accordance with the Safe Drinking Water Act (SDWA), the INEEL drinking water system and water supply wells are regularly monitored for gross alpha and gross beta radiation. Because Tc-99 is a beta emitter, if elevated Tc-99 activity were ever to be present in the INEEL drinking water systems, elevated gross beta levels would be detected. Conversely, low gross beta activities demonstrate the absence of significant concentrations of beta-emitting radionuclides, including Tc-99. Based on data collected from 1995 to present, the highest gross beta values reported for the INTEC water supply wells CPP-04 and CPP-05 were  $7 \pm 5$  pCi/L for both wells when they were sampled on March 21, 1996. The highest gross beta values reported during this time period for CFA production wells CFA-1 and CFA-2 were  $16.1 \pm 1.58$  pCi/L (November 13, 2001) and  $8.36 \pm 0.953$  pCi/L (January 19, 2000), respectively. The low gross beta values confirm the absence of elevated Tc-99 concentrations in these water supply wells.

INTEC nonpotable raw water supply wells CPP-01 and CPP-02 have also been sampled for Tc-99, and the results are shown in Table 3-4. Raw water well CPP-01 is the easternmost of the two raw water wells (Figure 2-1) and has repeatedly shown slightly elevated Tc-99 concentrations, with a maximum concentration of  $44.7 \pm 3.09$  pCi/L reported for a sample collected October 2, 2003. A groundwater sample collected June 5, 1995, reportedly contained Tc-99 at  $31 \pm 1$  pCi/L. These observations appear to confirm that detectable concentrations of Tc-99 have been present in the aquifer near CPP-01 for at least 8 years. Groundwater quality at CPP-01 has also been impacted by service waste discharges to the former INTEC injection well, first in 1959 (Rhodes 1960) and later in 1970-71 (Amberson 1972a, b). In contrast, Tc-99 has not been detected in raw water well CPP-02, which is located approximately 500 ft west of CPP-01 (Figure 2-1).

Table 3-2. Summary of 2003 groundwater results for selected constituents at ICPP-MON-A-230.

Constituent	Units	Minimum	Maximum	Mean	Std. Dev.	Number of Samples
<b>Radionuclides</b>						
Tc-99	pCi/L	2,000	3,160	2,790	339	27
I-129	pCi/L	0.117	0.234	0.155	0.045	6
Sr-90	pCi/L	6.3	9.5	7.77	0.93	20
Tritium	pCi/L	4,640	5,730	5,210	351	19
U-233/-234	pCi/L	1.83	1.91	1.88	0.04	3
U-235	pCi/L	0.189	0.206	0.189	0.012	2
U-238	pCi/L	1	1.33	1.32	0.19	3
Gross alpha	pCi/L	32.7	92	61.5	29.6	3
Gross beta	pCi/L	931	1,220	1,120	147	3
<b>Inorganics</b>						
Total alkalinity	mg/L CaCO <sub>3</sub>	135	136	135.5	0.71	3
Chloride	mg/L	64.4	65.6	65	0.85	3
Nitrate	mg/L as N	9.1	9.1	9.1	N/A <sup>a</sup>	1
Sulfate	mg/L	46.6	47.2	46.9	0.42	2
Calcium	mg/L	63.0	63.8	63.4	0.57	2
Magnesium	mg/L	20.1	20.3	20.2	0.14	2
Potassium	mg/L	4.42	4.48	4.45	0.04	2
Sodium	mg/L	28.9	29.6	29.2	0.49	2

a. N/A = not applicable.

Table 3-3. Summary of Tc-99 concentrations in INEEL drinking water and drinking water supply wells.

Location	Sample Date	Sample Collected By	Tc-99 Concentration (pCi/L)	Uncertainty (pCi/L, ±1 sigma)	Data Qualifier Flag
CFA drinking water	03/13/02	INEEL	3.75	1.94	U <sup>a</sup>
CFA drinking water	04/24/02	INEEL	<b>4.35</b>	<b>1.18</b>	J <sup>b</sup>
CFA drinking water	08/20/02	INEEL	3.27	0.817	UJ
CFA drinking water	08/19/03	INEEL	<b>3.51<sup>c</sup></b>	<b>0.782</b>	—
CFA drinking water	08/19/03	INEEL	<b>4.49</b>	<b>0.304</b>	—
CFA drinking water	11/19/03	INEEL	4.71	1.73	U
CFA Well #1	03/13/02	INEEL	4.98	1.74	UJ
CFA Well #1	04/24/02	INEEL	<b>6.81</b>	<b>1.37</b>	J
CFA Well #1	08/20/02	INEEL	<b>8.04</b>	<b>1.06</b>	J
CFA Well #1	11/19/03	INEEL	3.59	2.06	U
CFA Well #2	03/13/02	INEEL	0.061	1.85	U
CFA Well #2	04/24/02	INEEL	1.30	1.25	U
CFA Well #2	08/20/02	INEEL	2.83	0.83	UJ
CFA Well #2	11/19/03	INEEL	1.08	1.72	U
INTEC drinking water	08/19/03	INEEL	1.50	0.979	U
INTEC drinking water	08/19/03	INEEL	0.358	0.36	U
INTEC drinking water	12/18/03	INEEL	-3.13	1.54	U

a. U = not detected.

b. J = estimated value.

c. **Bolded** values indicate Tc-99 was detected in sample.

Table 3-4. Summary of Tc-99 concentrations in INTEC raw water wells CPP-01 and CPP-02.

Location	Sample Date	Sample Collected By	Tc-99 Concentration (pCi/L)	Uncertainty (pCi/L, ±1 sigma)	Data Qualifier Flag
CPP-01	06/05/95	INEEL	31	1	J <sup>a</sup>
CPP-01	10/02/03	INEEL	44.7	3.09	J
CPP-01	10/13/03	INEEL	26.3	2.10	—
CPP-01	12/16/03	INEEL	10.5	1.88	—
CPP-02	06/05/95	INEEL	1.1	0.5	—
CPP-02	10/09/03	INEEL	2.84	1.43	U <sup>b</sup>
CPP-02 <sup>c</sup>	10/09/03	INEEL	1.19	1.73	U
CPP-02	10/13/03	INEEL	0.797	1.45	—
CPP-02	12/16/03	INEEL	-4.32	2.38	—
Raw water <sup>d</sup>	10/22/02	INEEL	23.6	2.35	—

a. J = estimated value.

b. U = not detected.

c. Duplicate sample.

d. Raw water sample blend from CPP-01 and CPP-02 as reported in Cahn and Ansley (2003).

### **3.4 Evaluation of Well Construction and Vadose Zone Stratigraphy**

Monitor well ICPP-MON-A-230 (also known as the tank farm aquifer well, or TF-Aquifer) was installed during 2001 as part of the Waste Area Group (WAG) 3, Group 4, Perched Water monitoring activities and was screened at a depth of 443 to 483 ft bgs in the uppermost portion of the SRPA. The well completion diagram for ICPP-MON-A-230 is shown in Figure 3-2. As shown on the well completion diagram, ICPP-MON-A-230 was completed with a telescoped well construction to minimize the potential for any shallow contamination to migrate to deeper depths. The casing sizes and depths installed at ICPP-MON-A-230 are

- 20-in. steel surface casing to 43 ft bgs
- 16-in. steel casing to 203 ft bgs
- 12-in. steel casing to 399 ft bgs
- 6-in. stainless steel casing to 443 ft bgs
- 6-in. stainless steel screen to 443 to 483 ft bgs.

The use of four successively smaller diameter casing strings is referred to as a telescoped well construction. This method is the current state of the art for monitoring wells installed in potentially contaminated areas. Each casing string was emplaced using bentonite chips to seal the borehole annulus.

In addition to aquifer monitor well ICPP-MON-A-230, four shallower monitor wells of the Tank Farm Well Set were installed nearby to various depths in the vadose zone to monitor potential perched water zones. Unlike the less costly method of installing multiple wells in a single borehole (nested wells), the five monitor wells of the Tank Farm Well Set were each installed in separate boreholes. This method, though more costly, minimizes the possibility that a borehole could serve as a conduit that could permit downward transport of contaminated water to deeper depths.

The field logbooks completed during drilling of the Tank Farm Well Set were reviewed for evidence of perched water encountered during drilling. The following information excerpted from the logbook (Garcia 2001) and confirmed by review of downhole videologs summarizes available information regarding perched water observed on downhole videologs just prior to well completion:

#### **ICPP-MON-A-230 (Tank Farm Aquifer Well):**

- Videolog of March 12, 2001, shows
  - Water entering hole at 272 ft; damp below this depth
  - More water entering hole at 338 ft; drippy below this depth
  - More water entering hole at 347 ft; cascading below this depth
- 12-in. steel casing installed to 399-ft depth to seal off upper portion of borehole
- 6-in. stainless steel well screen placed at 443 to 483 ft

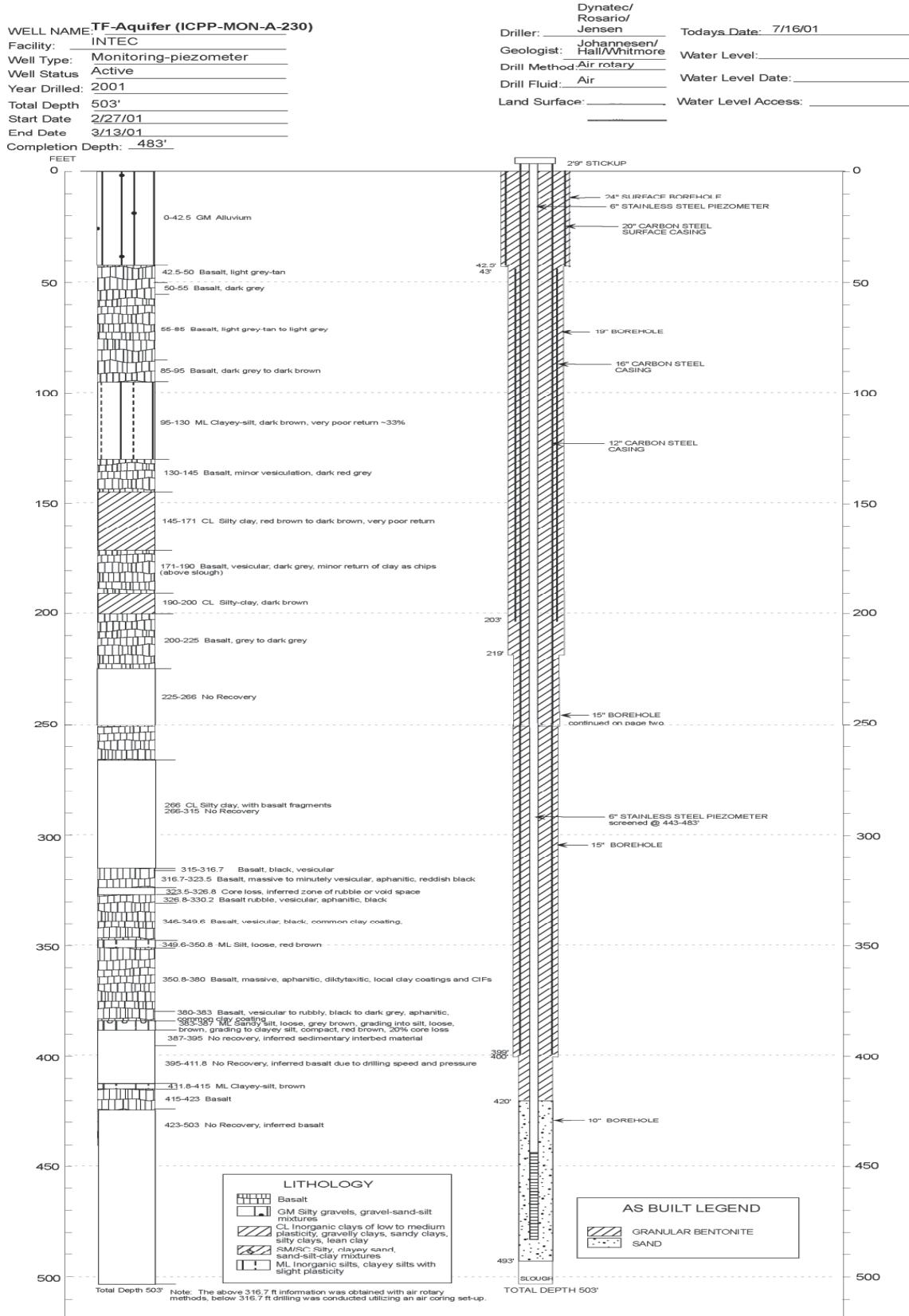


Figure 3-2. Well completion diagram for ICPP-MON-A-230.

- Monitor well sand filter pack installed from 420 to 493 ft
- Bentonite seal installed surface to 420 ft on March 20, 2001.

**ICPP-SCI-P-252 (Tank Farm Core Hole):**

- Videolog of February 13, 2001, shows
  - Water entering hole at 172 ft; damp below this depth
  - More water entering hole at 184 ft; drippy/cascading below this depth
- Bentonite seal installed from 152 ft to 325 ft
- 2-in. stainless steel well screen placed at 145 to 150 ft
- Monitor well sand filter pack installed from 140 to 152 ft
- Bentonite seal installed from surface to 140 ft.

In summary, there is ample evidence that perched water is present at several depths at the location of the Tank Farm Well Set. However, except for the very short time that elapsed between drilling and monitor well completion, there is no indication that the Tank Farm Well Set boreholes have allowed downward vertical transport of perched water.

**Other Evidence of Perched Water at Tank Farm Well Set:**

Neutron logging of ICPP-MON-A-230 was performed by the USGS on October 23, 2003, to evaluate the presence of moisture and/or perched water outside of the monitor well casing. The neutron moisture log is included in Appendix B. As expected, the neutron log was somewhat attenuated by the bentonite annular seal of the monitor well. Nevertheless, USGS interpreted the neutron log to indicate several depths where perched water may be present<sup>c</sup>:

- Basalt unit at 171 ft to 190 ft appears saturated (between two interbeds)
- Possibility of water moving vertically through fractures from 282 ft to 360 ft
- Possible perched water at 380 ft to 400 ft within sedimentary interbed.

The depth interval from 171 to 190 ft appeared to be the most likely zone where water could be present outside the well casing.

Additional evidence for the presence of perched water is provided by the tensiometers installed at the Tank Farm Well Set (DOE-ID 2003d). Data for April 2003 to September 2003 indicate that

- Tensiometer TF-AL at 35-ft depth indicates saturated conditions (+20 cm water potential).

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c. Twining, Brian (btwining@usgs.gov), "Neutron Logging Results for ICPP-MON-A-230," Jeff Forbes (forbjr@inel.gov), October 27, 2003.

- Tensiometer TF-SP2 at 157-ft depth indicates saturated conditions (+100 cm water potential).
- Tensiometer TF-DP2 at 388-ft depth indicates nearly saturated conditions (-10 cm water potential).

In spite of the indications of perched water, the only perched monitor well in the Tank Farm Well Set that has contained sufficient water to permit sample collection has been the shallow monitor well completed in the alluvium (TF-AL or ICPP-SCI-P-227). This well contains only very low concentrations of radionuclides of concern, in most cases at or below detection limits (DOE-ID 2003d).

In summary, both the neutron log run in October 2003 and the tensiometer data for 2003 appear to substantiate the continued presence of perched water observed previously on the 2001 videologs at the Tank Farm Well Set. One source of recharge to the perched water zones near the Tank Farm Well Set is the east-west ditch located approximately 350 ft north of the Tank Farm Well Set. This ditch receives water released during periodic testing of the INTEC fire hydrants (DOE-ID 2003e), as well as surface water runoff from natural precipitation. The magnitude of this and other recharge sources at INTEC is being evaluated.

A review of the vadose zone stratigraphy was performed to evaluate the potential for vertical and lateral water movement through the vadose zone in the vicinity of the Tank Farm Well Set. Figure 3-3 is a geologic cross section through the Tank Farm Core Hole (ICPP-SCI-P-252), which is adjacent to monitor well ICPP-MON-A-230. Figure 3-4 is a plan view map showing the location of this cross section (green line), as well as others prepared as part of the Monitoring Well and Tracer Study (MWTS) (DOE-ID 2003b). Appendix B of that study gives a detailed discussion of the stratigraphy underlying INTEC.

The cross section (Figure 3-3) illustrates the inferred relationships between the various basalt flows and sedimentary interbeds underlying the tank farm area. As shown on the cross section, the basalt is highly fractured between the 140-ft interbed and the Middle Massive Basalt Flow (shown in green). In addition, the 110-ft interbed that exists elsewhere beneath INTEC was not present at the Tank Farm Well Set. Examination of the core photos (Appendix C) confirms the presence of numerous rubble zones within the basalt at the Tank Farm Well Set. For example, a rubble zone is present at the tank farm core hole at depths of 300 to 320 ft bgs. These rubble zones may constitute high-permeability pathways for vertical or lateral flow of perched water, where present. Rapid lateral flow of water along similar rubble zones has been observed during tracer tests performed elsewhere at the INEEL (Nimmo et al. 2002).

### **3.5 ICPP-MON-A-230 Pumping Test**

A 5-hour step-drawdown pumping test was planned at monitor well ICPP-MON-A-230 to (1) estimate the transmissivity of the upper portion of the SRPA at this location and (2) determine whether the Tc-99 detected in the well is limited to the immediate vicinity of the borehole or, instead, is more widespread in the aquifer. In preparation for the pumping test, a 15-hp submersible pump was installed in the well on October 27, 2003. On October 28, the well was developed by pumping for 1 hour at 84-86 gpm. A groundwater sample was collected at the start of the well development period, and another was collected at the end for laboratory analysis. The samples were analyzed for Tc-99 and other selected radionuclides, and the results are included in Appendix A. A total of approximately 5,000 gal of water was pumped from the monitor well during the well development period, and the water was observed to be clear at the end of the development period. All of the water was contained in two double-walled Baker tanks for subsequent disposal at the INEEL CERCLA Disposal Facility (ICDF) evaporation ponds, in accordance with the Work Plan (ICP 2003).

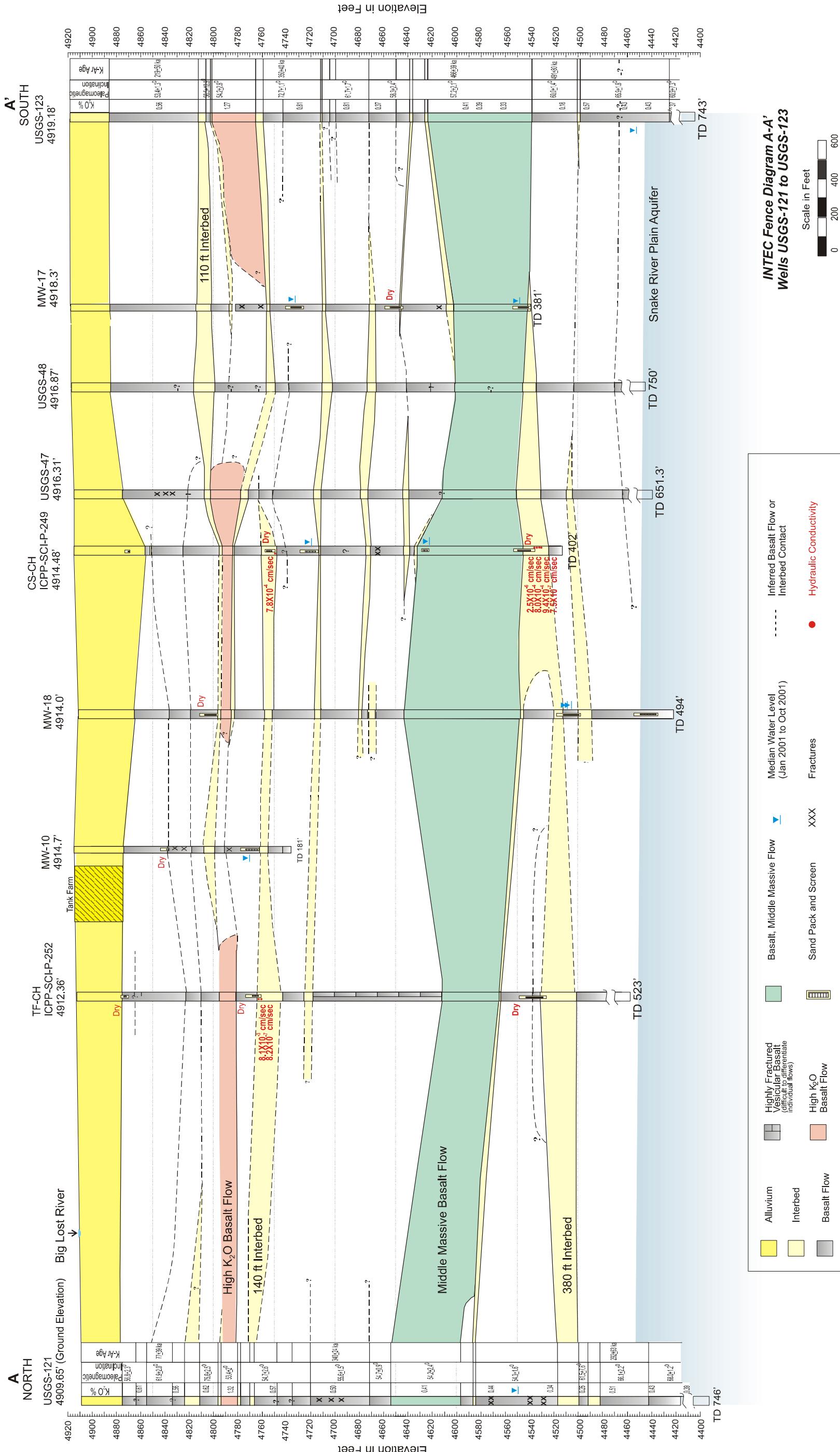


Figure 3-3. Geologic cross section through Tank Farm Well Set and tank farm area.

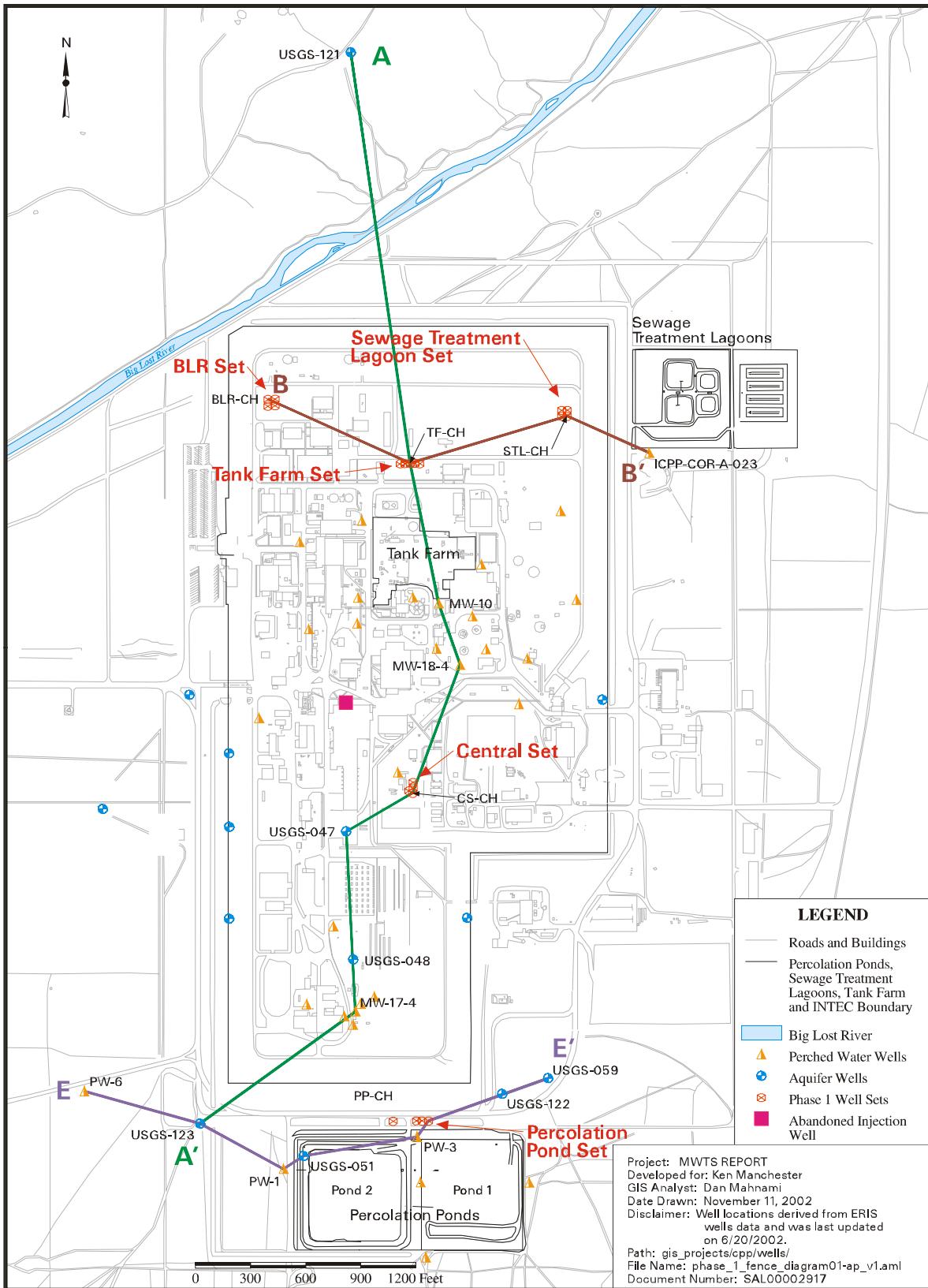


Figure 3-4. Cross section location map.

On October 30, 2003, a step-drawdown pumping test was conducted by pumping groundwater from ICPP-MON-A-230 at progressively higher pumping rates. Each pumping rate was sustained for 1 hour before proceeding to the next higher step. The five pumping rates were 20, 35, 50, 65, and 86 gpm. The highest pumping rate was the highest flow achievable with the available pump. Water levels in the well were measured using a Solinst electric water level indicator. Approximately 16,000 gal of water were pumped from the monitor well during the 5-hour-long pumping test. All of the water was contained in two double-walled Baker tanks for subsequent disposal at the ICDF, in accordance with the Work Plan (ICP 2003).

During the pumping test, a groundwater sample was collected at the start of the test, and additional samples were collected at the end of each hour-long step. Field parameters were measured simultaneously with sample collection, including temperature, pH, electrical conductivity, dissolved oxygen, and oxidation-reduction potential. The water samples were submitted to the laboratory for analysis of Tc-99, Sr-90, and tritium. Groundwater quality field and laboratory results are included in Appendix A.

Figure 3-5 shows the observed drawdowns for each pumping step. At the highest pumping rate (86 gpm), the drawdown was only 1.6 ft (below static water level), and when the pump was shut off at the conclusion of the test, essentially full recovery occurred within less than 10 seconds. This indicates a very high hydraulic conductivity for the aquifer in the vicinity of the well. This observation is consistent with the high permeabilities previously measured in nearby water supply wells CPP-01 and -02 (Anderson et al. 1999) and with the fractured/rubbly nature of the basalt at the depth of the water table ( $\approx 460$  ft bgs). Specific capacities calculated from the step-drawdown test ranged from 150 gpm per foot of drawdown at the lowest pumping rate (20 gpm) to 53 gpm per foot of drawdown at the maximum pumping rate of 86 gpm. These values are quite high, especially considering that the well is only screened over the upper 18 ft of the aquifer.

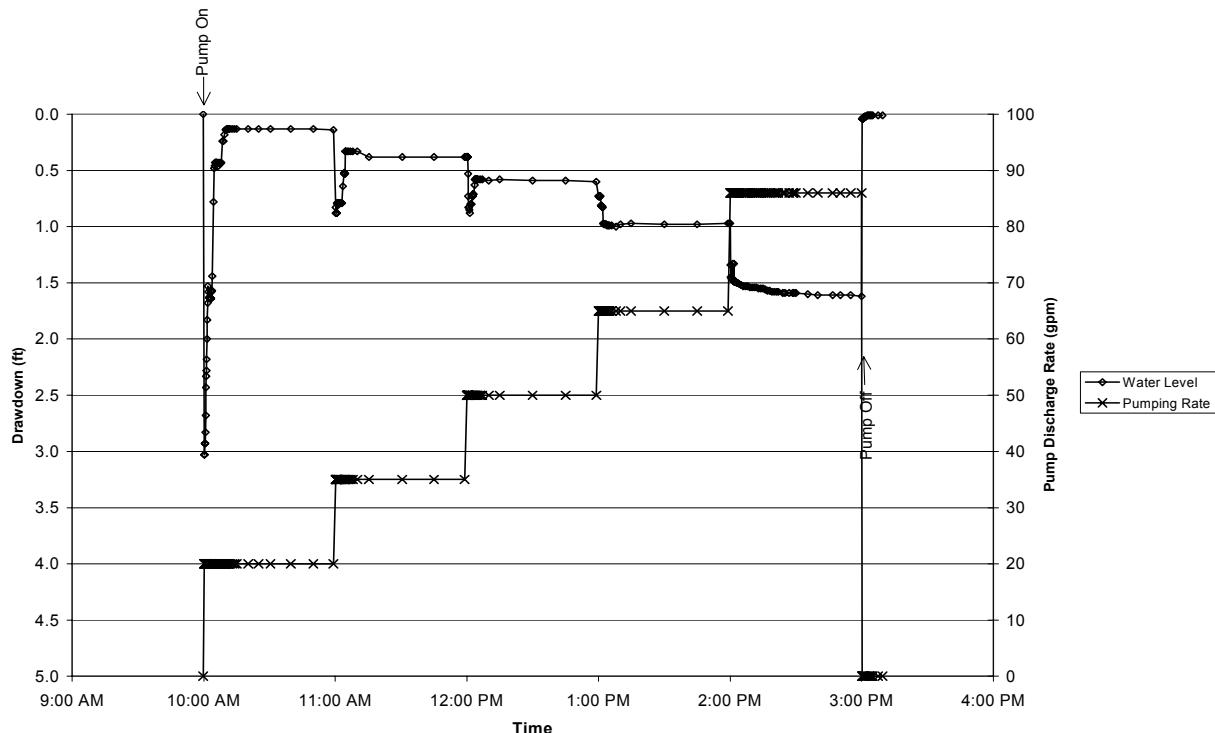


Figure 3-5. Hydrograph and pumping rate for October 30, 2003, pumping test at ICPP-MON-A-230.

In general, single-well pumping tests cannot be used to accurately calculate aquifer transmissivity and hydraulic conductivity. However, the results of short-duration single-well tests may be used to estimate these aquifer properties. Several methods were applied to estimate aquifer permeability using the step-drawdown test results. The AQTSOLV software was used to apply the Theis curve matching method to the data from the first pumping step (20 gpm). This approach yielded a hydraulic conductivity estimate of 4,100 ft/day and assumed a confined aquifer with a saturated thickness equal to the height of the water column in the well (18 ft). Using these same assumptions, application of the step-drawdown test analysis method of Driscoll (1986) to the first pumping step (20 gpm) yielded a K value of 2,300 ft/day. Applying the method of Logan (1964) to these same data gave an estimated K of 2,000 ft/day. Using data from the subsequent pumping steps yielded slightly lower hydraulic conductivity values, but the data from the first pumping step are deemed more reliable because well loss effects would be less than for subsequent steps. In summary, the pumping test results indicate that the SRPA is quite permeable at the location of monitor well ICPP-MON-A-230, with estimated hydraulic conductivities in the range of 2,000 to 4,000 ft/day. These values would fall near the upper end of hydraulic conductivities reported in the SRPA (Anderson et al. 1999).

Figures 3-6 through 3-8 show the concentrations of Tc-99, Sr-90, and tritium observed during the step-drawdown test. The concentrations of Sr-90 and tritium ( $\pm 1$  standard deviation) remained nearly constant over the course of the test, but the concentration of Tc-99 in groundwater decreased slightly with each increasing pumping rate (Figure 3-6).

Given the high permeability of the aquifer at this location and the maximum-size submersible pump that would fit in the 6-in. monitor well, it was not possible to thoroughly “stress” the aquifer during the pumping test. In addition, the duration of the pumping test was limited by the quantity of water that could be contained in the Baker tanks at the well site for subsequent disposal in the ICDF. Nevertheless, the pumping test was successful in achieving its two primary objectives, which were to (1) determine if Tc-99 concentrations persisted in the groundwater during a period of hours of pumping and (2) estimate the hydraulic properties of the aquifer.

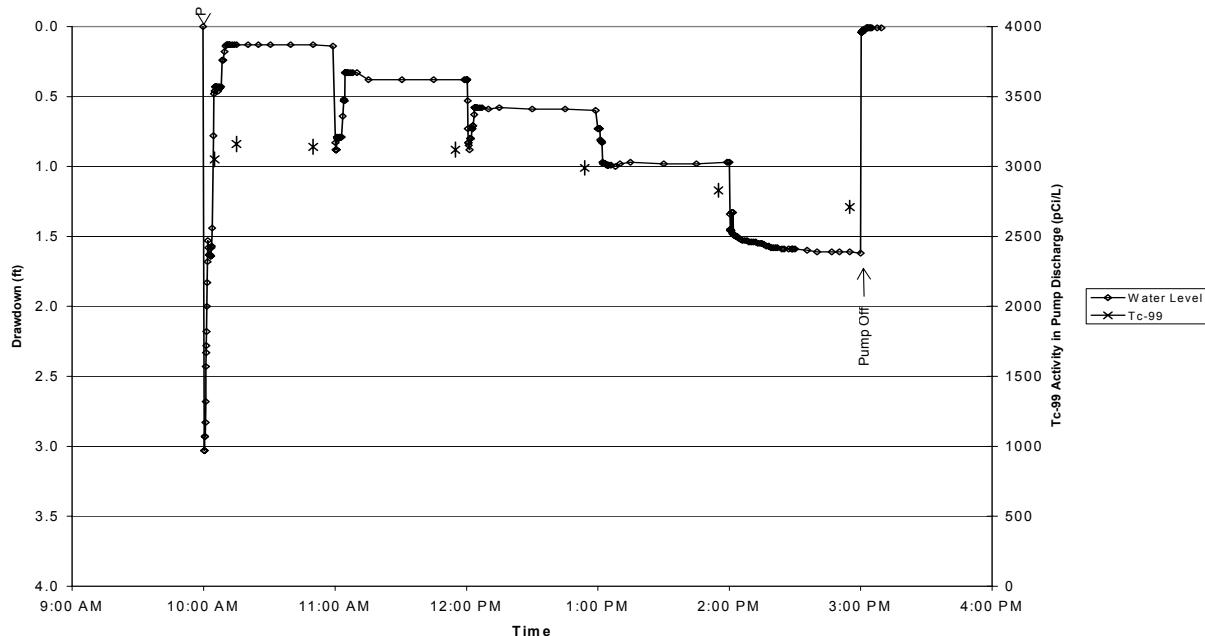


Figure 3-6. Tc-99 concentrations in groundwater during step-drawdown test at ICPP-MON-A-230.

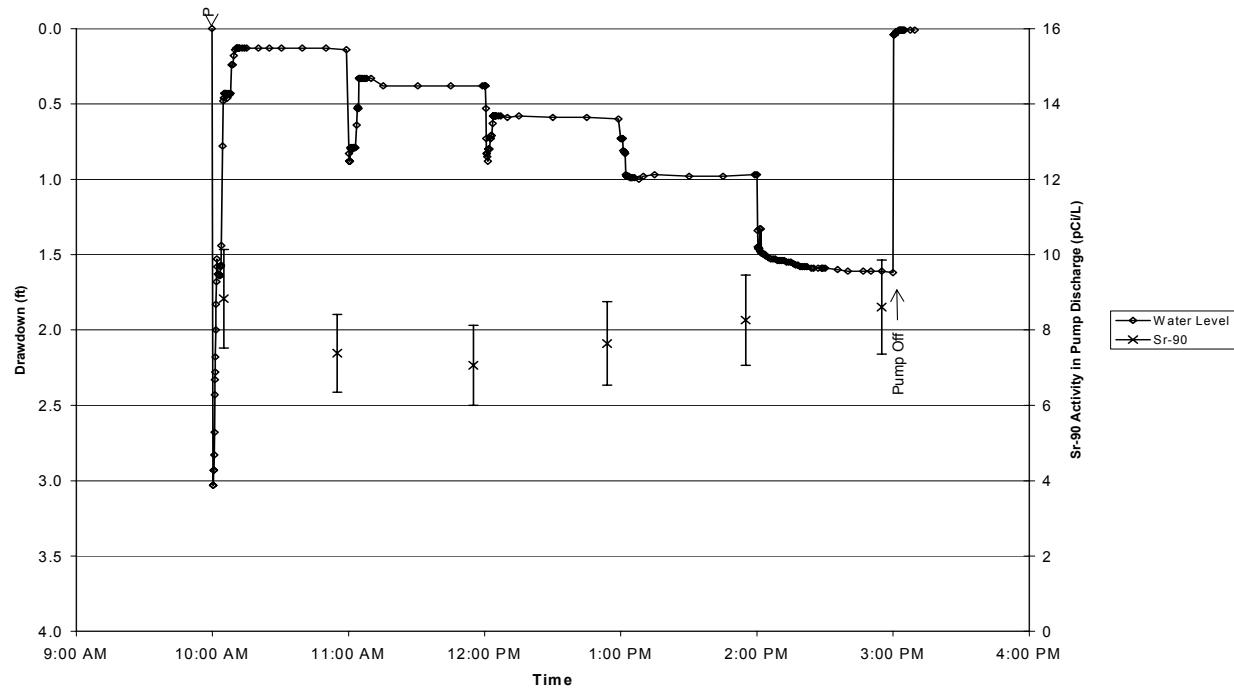


Figure 3-7. Sr-90 concentrations in groundwater during step-drawdown test at ICPP-MON-A-230.

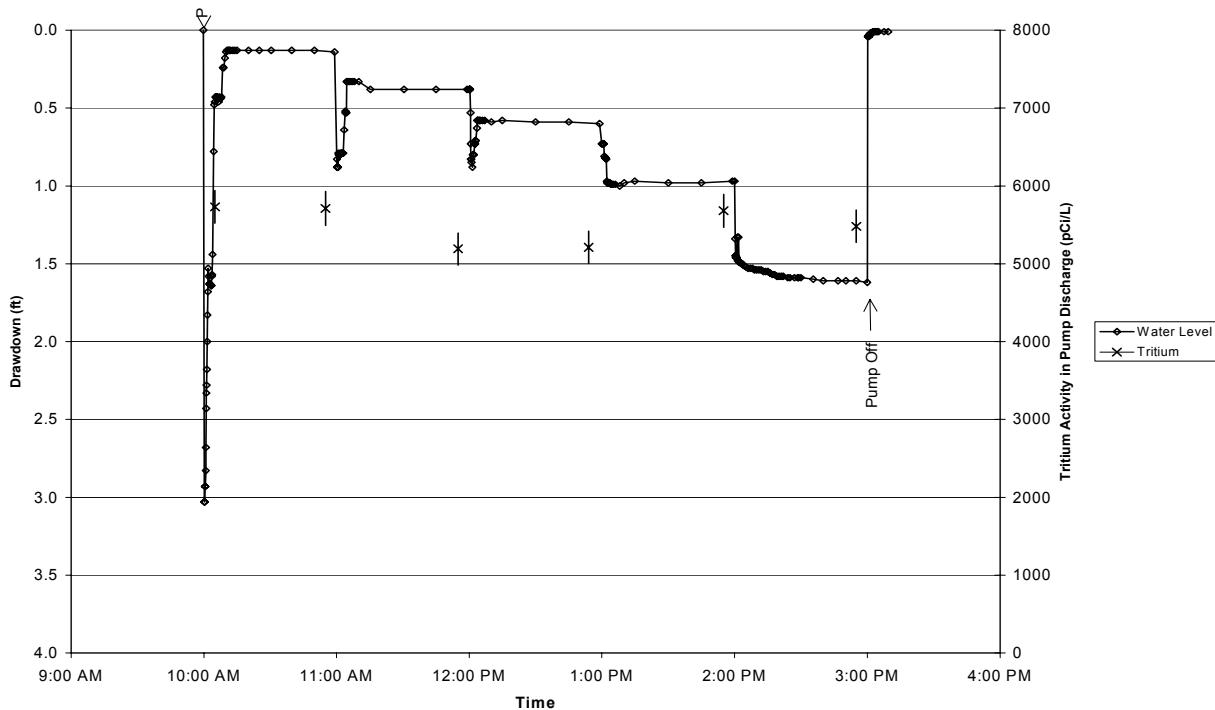


Figure 3-8. Tritium concentrations in groundwater during step-drawdown test at ICPP-MON-A-230.

Approximately 16,000 gal of groundwater were pumped from ICPP-MON-A-230 during the step drawdown test, which is equivalent to 2,100 ft<sup>3</sup>. Dividing this volume by the assumed effective porosity of 0.03 for the aquifer gives an aquifer volume of 71,000 ft<sup>3</sup>. The height of the water column (saturated thickness) in the well under nonpumping conditions was 18 ft. Assuming horizontal radial flow to the well in a homogeneous aquifer (cylindrical volume of influence), the area of circle affected by pumping is

$$A = V/h = 71,000/18 = 3,940 \text{ ft}^2$$

where:  $V$  = volume of aquifer

$h$  = static water column height in well.

The radius of the circle around the well is then calculated as

$$R = (A/\pi)^{1/2} = (3,940/\pi)^{1/2} = 35 \text{ ft.}$$

This indicates that the water pumped from the well at the end of the pumping test was drawn from at least 35 ft from the monitor well, and the actual flow distance could have been greater through fractures that act as preferential pathways. The tank farm boundary is approximately 300 ft south of the monitor well, so it is unlikely that the pumping test drew water from directly beneath the tank farm. However, the test results demonstrate that the Tc-99 was present over an area of the aquifer that extends at least 35 ft away from the monitor well.

### 3.6 Radionuclide Results for Core Samples

Core samples obtained during drilling of the Tank Farm Well Set have been kept in storage at the INEEL Core Storage Facility. During drilling in 2001, core samples were collected from two boreholes of the Tank Farm Well Set. At the tank farm core hole (ICPP-SCI-P-252), core samples were retrieved from depths of 37 to 325 ft bgs, and detailed core logs and core photos were presented in the MWTS (DOE-ID 2003b). This boring is located approximately 50 ft west of monitor well ICPP-MON-A-230. At monitor well ICPP-MON-A-230, core samples were collected from 316 to 387 ft bgs. Because they were not included in the MWTS report, photographs of the core from ICPP-MON-A-230 are included in Appendix C.

Radiological screening performed during drilling in 2001 did not identify any core material with radiation levels above background (DOE-ID 2003b). However, as part of this study, the core samples were again screened for radioactivity to aid in selection of samples for laboratory testing. Radiological screening of the core was performed at the INEEL Core Storage Facility on November 5, 2003. The radiological control technician used a Ludlum 3 beta-gamma meter and a NEC Electra alpha meter to systematically screen the exterior surface of the entire length of cores from both borings (ICPP-MON-A-230 and ICPP-SCI-P-252). No beta-gamma activity above background levels was detected anywhere on the cores (all readings <100 dpm). For the majority of the core, alpha radiation was also at or below background levels (<20 dpm). The exception was an interval of slightly elevated alpha activity observed on the surface of the core from boring ICPP-SCI-P-252 at depths of 288 to 319 ft bgs. A peak alpha activity of 150 dpm was observed at the 293-ft depth. The alpha activity was determined to be "fixed," as a smear sample showed no detectable alpha activity.

Ten samples of the core material were collected for laboratory testing of selected radionuclides. Samples for laboratory analysis were selected from the following zones: (1) basalt from depths where perched water was potentially present, (2) sedimentary interbed material that could have adsorbed radionuclides,

and (3) depths with elevated alpha field screening results. Table 3-5 summarizes the sample depths, lithologies, and laboratory results. The complete laboratory results are included in Appendix D.

The lab results indicate that Tc-99, Sr-90, and gamma-emitting radionuclides were not present at detectable concentrations in the samples of core material. Gross alpha and gross beta activities ranged from  $2.03 \pm 0.877$  to  $16.7 \pm 1.65$  pCi/g and from  $3.61 \pm 1.10$  to  $33.0 \pm 1.76$  pCi/g, respectively. These values are similar to the background screening criteria of 20 pCi/g for alpha radiation and 30 pCi/g for beta radiation for INTEC alluvium used in the OU 3-13 Comprehensive Remedial Investigation/Feasibility Study Work Plan (INEL 1995). The laboratory results did not confirm the field alpha screening, which had indicated a slightly elevated fixed gross alpha activity within the depth interval of 288 to 319 ft bgs. The elevated screening results are believed to be attributable to naturally occurring uranium and/or thorium in the basalt. Chemical analysis of core samples indicates that concentrations of uranium and thorium of up to 2 ppm each are common in the basalts underlying INTEC (DOE-ID 2003b). Moreover, the lab results do not indicate the presence of Tc-99 in the basalt or interbed material within the vadose zone at monitor well ICPP-MON-A-230.

### 3.7 Colloidal Borescope Logging Results for ICPP-MON-A-230

To assess groundwater flow directions and velocities in the aquifer, an innovative tool, the colloidal borescope, was used for logging of monitor well ICPP-MON-A-230. The colloidal borescope was developed by Oak Ridge National Laboratory and tracks the movement of colloidal particles in groundwater as they are carried across the screened or perforated interval of a well. The colloidal borescope provides a direct measurement of the groundwater flow velocity in a well by directly observing the movement of naturally occurring particles (colloids) that are ubiquitous in groundwater. The colloidal borescope consists of a charged-couple device camera, an electronic compass for orientation, optical magnification lens, illumination source, and stainless steel housing (measuring 24 in. long with a diameter of 1.7 in.). Particles are magnified 140 times and observed at the surface on a video monitor. Colloidal movement in the groundwater is monitored using a video frame grabber that is capable of analyzing video images from the colloidal borescope several times per second. A software program analyzes the digitized video images, calculates the particle number, size, flow direction, and flow rate, and records the data to a computer (Kearl 1997).

The colloidal borescope was deployed at monitor well ICPP-MON-A-230 on October 22-23, 2003. Contractor Aquavision, Inc., operated the borescope under the supervision of a Bechtel BWXT Idaho hydrogeologist. The borescope was employed at several depths within the screened interval. Because placement of the tool in the well disturbs the natural groundwater flow, up to 30 minutes is required following tool placement before reliable data may be collected. Following return to normal groundwater flow, data collection typically requires 60 or more minutes at each depth to ensure that the natural fluctuations in groundwater flow velocity and direction are recorded (Shanklin 1996).

Figure 3-9 shows the results of the colloidal borescope logging of ICPP-MON-A-230, and additional details are included in Appendix E. As shown on the well completion diagram (Figure 3-2), the monitor well is screened from 443 to 483 ft bgs. At the start of the test, the depth to water in the well was 461.8 ft bgs. The borescope indicated significant lateral flow at two depths near the bottom of the well screen, at 477 ft and at 482 ft bgs. Southeasterly groundwater flow was observed at both depths (Figure 3-9), at estimated groundwater flow velocities in the range of 3 to 5 ft/day. These velocities were obtained by dividing the measured in-well velocities by four to account for the acceleration of groundwater near the well bore and to account for flow velocities outside of and away from the well bore, which are typically up to a factor of four lower than those measured with the borescope.

Table 3-5. Summary of radionuclide results for core samples.

Boring ID	Depth (ft bgs)	Lithology	Tc-99 (pCi/g)	Sr-90 (pCi/g)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Gamma Emitters <sup>a</sup> (pCi/g)
ICPP-SCI-P-252	43	Basalt, rubbly, weathered	U <sup>b</sup>	U	2.03 ± 0.877	3.61 ± 1.10	U
ICPP-SCI-P-252	105	Basalt, fractured, w/ clay infill	U	U	4.61 ± 1.22	9.67 ± 1.38	U
ICPP-SCI-P-252	155	Interbed, clay, brown	U	U	16.2 ± 1.68	24.6 ± 1.63	U
ICPP-SCI-P-252	195	Interbed, silty sand, red-brn	U	U	15.5 ± 1.50	33.0 ± 1.76	U
ICPP-SCI-P-252	274	Basalt, fractured	U	U	5.55 ± 1.19	7.42 ± 1.26	U
ICPP-SCI-P-252	293 <sup>c</sup>	Basalt, fractured	U	U	5.86 ± 1.40	8.20 ± 1.33	U
ICPP-SCI-P-252	305-306	Basalt, rubbly, weathered	U	U	5.01 ± 1.44	7.33 ± 1.41	U
ICPP-MON-A-230	350	Interbed, sandy silt, red-brn, loose	U	U	16.7 ± 1.65	28.2 ± 1.78	U
ICPP-MON-A-230	377	Basalt, rubbly, w/ interbed clay	U	U	10.9 ± 1.58	16.4 ± 1.80	U
ICPP-MON-A-230	385-387	Interbed, silt, gray-brn	U	U	11.5 ± 1.47	20.8 ± 1.89	U

a. Gamma-emitting radionuclides include Ag-108m, Ag-110m, Ce-144, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Nb-95, Ru-106, Sb-125, U-235, and Zn-65.

b. U = below detection limit.

c. Radiological screening indicates maximum fixed alpha activity at this depth (150 dpm).

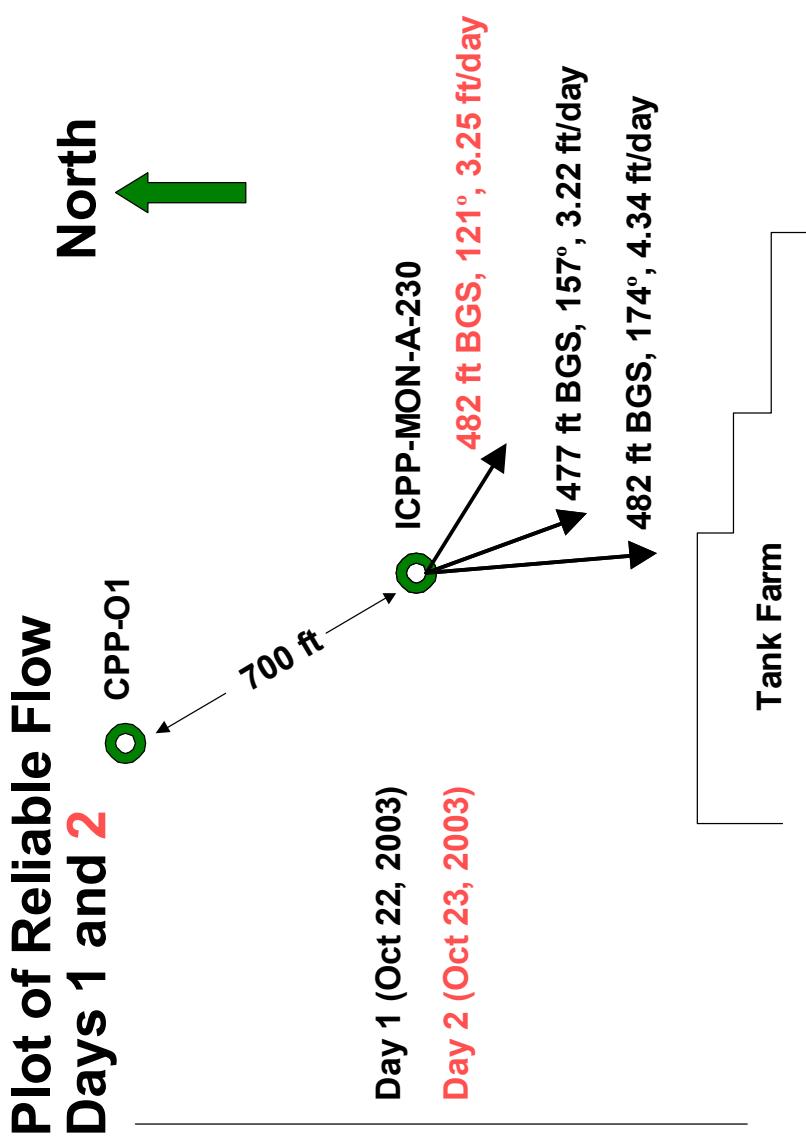


Figure 3-9. Summary of groundwater flow directions inferred using colloidal borescope.

On October 23, 2003, a test was performed to determine if pumping at INTEC raw water production well CPP-01 had a significant influence on groundwater flow at monitor well ICPP-MON-A-230. Colloidal borescope data collection began at ICPP-MON-A-230 at 9:22 a.m., and groundwater flow direction and velocity were monitored at the 482-ft depth (see Appendix E, page E-21). At 9:50 a.m., the groundwater flow azimuth was 128°, and flow velocity was 67 µm/sec. At 10:00 a.m., raw water production well CPP-01 was turned on and began pumping at 2,906 gpm. No immediate response at ICPP-MON-A-230 was observed. Instead, a gradual 10° eastward shift in groundwater flow direction occurred over the following hour, with flow velocities in the well remaining relatively constant. The gradual change in flow direction was similar to the slowly changing flow directions observed under normal conditions prior to startup of the pumping well. Therefore, it does not appear that cycling of the pump at CPP-1 had any immediate or obvious effect on groundwater flow at ICPP-MON-A-230.

### 3.8 Capture Zone Analysis of INTEC Well Field

Capture zone analysis of the INTEC raw water production wells (CPP-1 and CPP-2) and potable water wells (CPP-4 and CPP-5) was performed to determine if these wells could potentially capture groundwater at ICPP-MON-A-230 and/or beneath the tank farm. The analysis was performed using the MODFLOW and MODPATH computer software. MODFLOW is a three-dimensional groundwater flow simulator and MODPATH is particle tracking companion software for MODFLOW. The software was used to simulate groundwater flow paths near the tank farm and the INTEC production wells. Appendix F contains a detailed report summarizing the approach and results of the capture zone analysis.

The flow path analysis included simulations of both transient and steady-state pumping rates for the CPP-1, -2, -4, and -5 production wells. Pumping rates at the production wells were estimated from 2003 INTEC well operation logs. The capture zone modeling used a simplified lithology based on the Group 5 aquifer model, which only included the upper and lower basalt layers.

The steady-state pumping simulation with INTEC and Big Lost River recharge sources indicates the raw water well capture zone will extend approximately midway between the CPP-1 production well and ICPP-MON-A-230. The steady-state simulations with and without surface recharge indicated well capture zones are not significantly changed by the Big Lost River or INTEC facility recharge sources. Removing the Big Lost River and/or INTEC facility surface recharge did not have a dramatic effect on aquifer potentiometric surface because the volume of recharge water is relatively small and distributed over a large area compared to the volume of water pumped from the raw water production wells.

The transient simulations provide the most realistic evaluation of the INTEC production well capture zones because they include the effects of pumping cycles at the production wells. Figure 3-10 shows the transient simulation well field capture zone for 784 days of pumping with bimonthly alternation between well CPP-1 and well CPP-2. This simulation indicates the CPP-1 well capture zone extends to within approximately 40 m of the tank farm aquifer well. Transient simulations were only performed for a relatively short period of time compared to INTEC operational history because of computational restraints. The twice-daily cycle and large production volume of the raw water wells CPP-1 and CPP-2 require a large number of simulation time steps even for a short simulation period. The transient analysis was performed to determine sensitivity to the semi-daily cycling on and off of the well, and the bimonthly alternation between the CPP-1 and CPP-2 raw water wells.

The twice daily cycling on and off of the CPP-1 well did not have a significant impact on the size and shape of the simulated well field capture zone. This is because the short pumping cycle and recovery period did not allow the aquifer to completely recover between cycles. The only difference between the steady-state and transient simulation flow paths was a slight zigzag pattern within the transient flow paths.

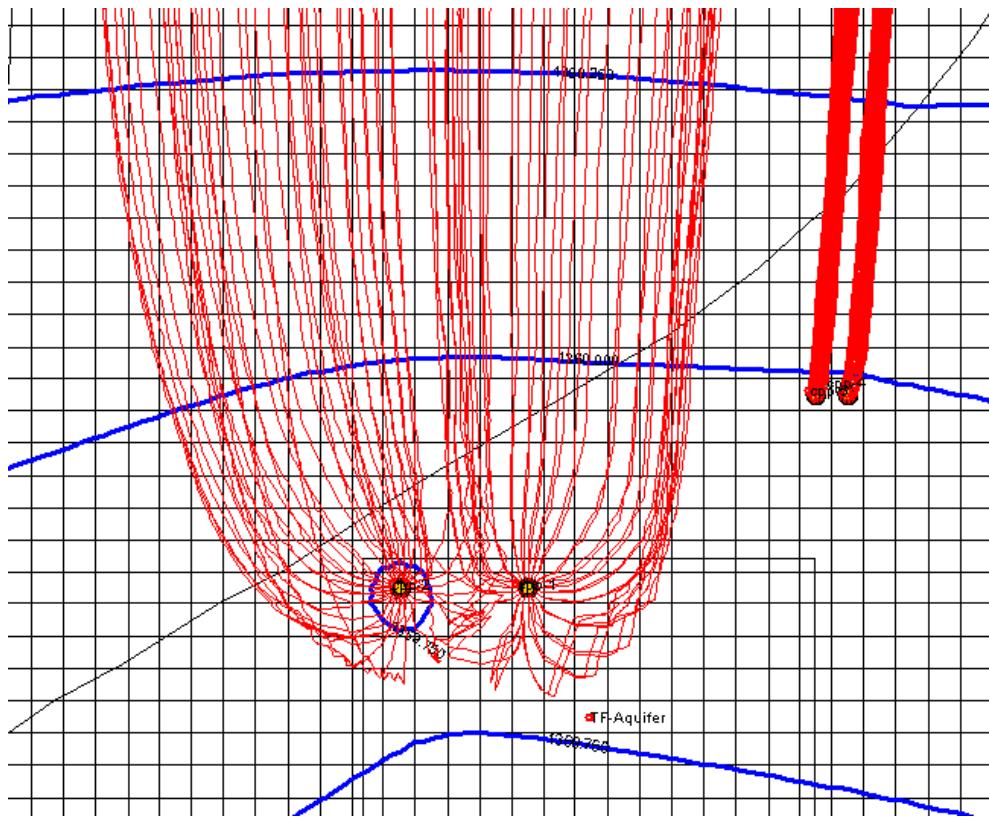


Figure 3-10. Simulated well field capture zone for 784 days of bimonthly alternating pumping between well CPP-1 and well CPP-2.

The bimonthly alternation between CPP-1 and CPP-2 has a large impact on size of the capture zone because the 2-week operation period and the 2-week inactive period allows the aquifer drawdown to reach steady state during pumping and fully recover during the shutdown period.

The results of the capture zone analysis show that the relatively small pumping rate of potable water wells CPP-4 and CPP-5 and large aquifer permeability result in the capture zones extending less than 20 m south of the potable water wells. Conversely, the large pumping rates for raw water wells CPP-1 and CPP-2 result in a very large capture zone extending approximately 150 m south or 3/4 of the distance to the tank farm aquifer well. The steady-state drawdown at CPP-1 is approximately 0.22 m and transient drawdown is approximately 0.37 m. The groundwater mounding resulting from the Big Lost River and other surface recharge sources is only a small fraction of this value and small compared to the large-scale gradient. The steady-state simulations with and without surface recharge indicated well capture zones are not significantly changed by the Big Lost River or INTEC facility recharge sources.

It is important to note that the simulations presented in this report assume the fractured basalt aquifer beneath the INTEC behaves as an equivalent isotropic porous medium and can be simulated as such. Flow is only considered in the basalt fractures and is assumed to behave as a low-porosity and high-permeability equivalent porous medium. The actual capture zones may be influenced by preferential flow paths due to rubble zones that occur near individual flow top and bottoms. When the injection well was operational prior to 1984, the capture zone of CPP-01 and -02 extended further south than at present as a result of the increased hydraulic gradient. Moreover, CPP-01 captured some service waste sent to the injection well in 1959 (Rhodes 1960), which indicates that the capture zone extended at least to the injection well at that time.

### 3.9 Evaluation of Tc-99 Sources at INTEC

When the elevated concentration of Tc-99 was detected in the May 2003 groundwater sample from ICPP-MON-A-230, the source of the Tc-99 had not been identified. Therefore, an evaluation of potential Tc-99 sources at INTEC was performed. Because of its low activity compared to other fission products present in SNF, relatively few Tc-99 data are available as compared to other radionuclides.

To assess potential Tc-99 sources at INTEC, an inventory of the amounts of Tc-99 historically present at the facility (as of July 1999) are summarized below (Swenson 2003):

3,450 Ci in stored calcine waste
224 Ci in remaining liquid and solid wastes in the INTEC tank farm
6 Ci shipped off-Site
3,680 Ci total Tc-99 in SNF reprocessed at INTEC

The total above does not include the Tc-99 that may have been released to the environment. The quantity that was released is unknown, but is estimated to be a fraction of 1% of the total quantity of Tc-99 in the SNF reprocessed at INTEC.<sup>d</sup> To address this data gap, an evaluation of the source or sources of elevated Tc-99 activity in ICPP-MON-A-230 was performed. A report documenting the approach and results of this evaluation is included in Appendix G. Below is a summary of available information regarding the magnitude of Tc-99 releases to soil and groundwater.

The RI/BRA estimated that the CPP-31 liquid release that occurred in November 1972 contained between 0.95 and 4.0 Ci Tc-99, with the average value being 2.58 Ci (DOE-ID 1997). That report further estimated that the CPP-31 release accounted for 95.9% of the Tc-99 mass released to the aquifer. The CPP-31 release site is located near the underground tanks at the INTEC tank farm (Figure 3-11). More recent assessments of the quantities of radionuclides present in historical releases at the tank farm confirm previous estimates of 2 to 3 Ci Tc-99 that have been released to tank farm soils. Additional information regarding the nature and extent of radionuclides beneath the INTEC tank farm will be generated during the OU 3-14 Remedial Investigation/ Feasibility Study (DOE-ID 2004b).

No records exist to document Tc-99 concentrations in the service waste that was previously disposed of in the former INTEC injection well, but the existence of a dilute plume of Tc-99 in the aquifer downgradient of INTEC strongly suggests that the former injection well could have been a source of Tc-99 to groundwater. Based on summation of the observed amounts of Tc-99 in the groundwater plume that existed in 1991-92, Beasley et al. (1998) estimated that a total of approximately 15 Ci of Tc-99 were present in the SRPA. The authors attributed the Tc-99 in the SRPA to waste disposal at the former INTEC injection well, which was used from 1953 until 1986 for disposal of service waste. Their estimate of 15 Ci Tc-99 in the aquifer was based on assumptions that the active flow zone of the SRPA has a thickness of 50 m and an effective porosity for the basalt aquifer of 23%. Based on more recent data, the current WAG 3 aquifer model assumes an effective porosity of 3% (Appendix F). The use of the higher-porosity value by Beasley et al. (1998) could result in their calculations significantly overestimating the total Tc-99 in the aquifer. Applying the 3% porosity value to their analysis would result in revising their estimate of the total Tc-99 in groundwater from 15 Ci down to 2 Ci.

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d. Swenson, M. C., 2003, personal communication with J. Forbes, December 2, 2003.

## Tank Farm Soils

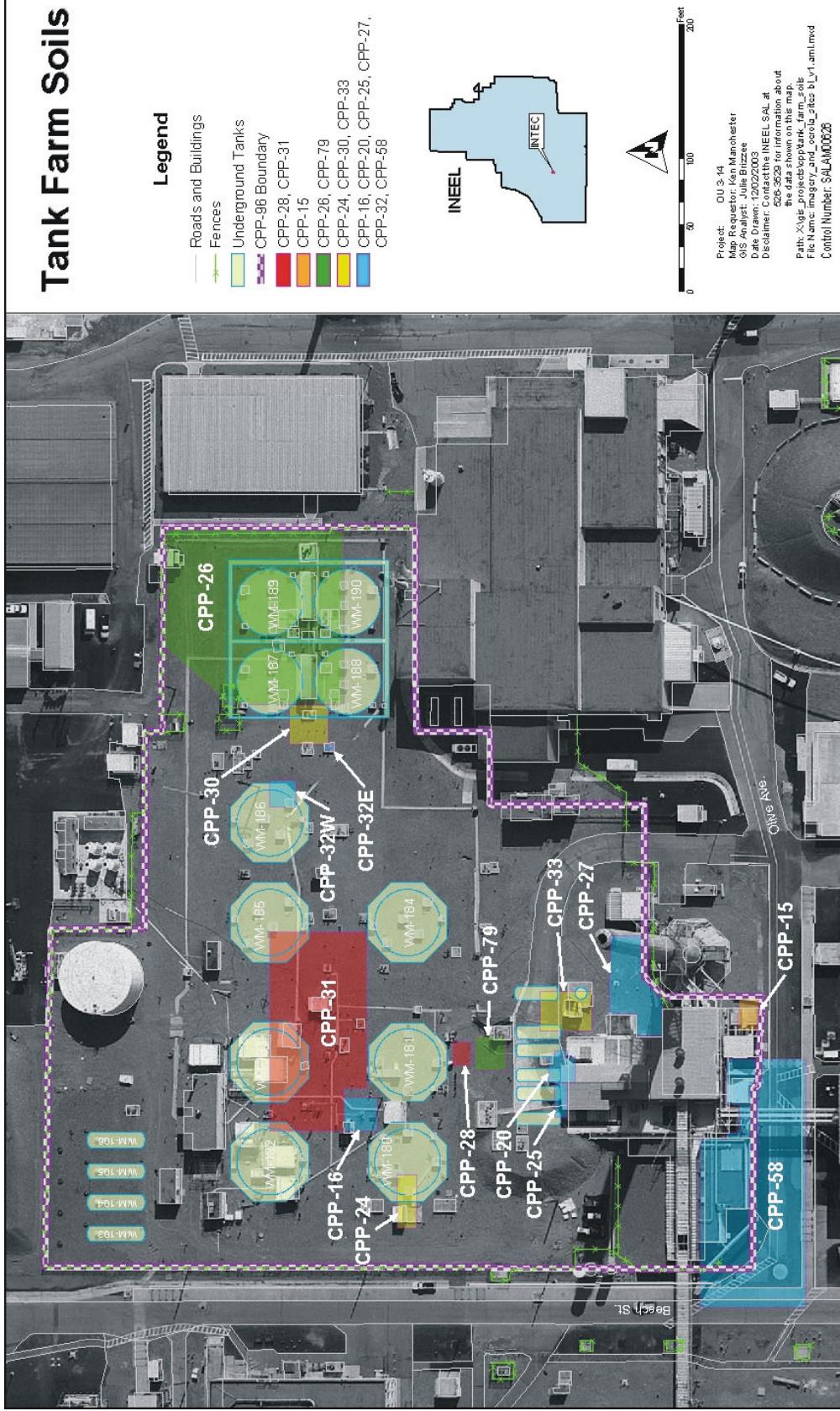


Figure 3-11. CERCLA sites at INTEC tank farm.

There are two basic ways that Tc-99 could have entered the service waste stream that was sent to the former injection well, either as a volatile species that passed across the process equipment waste (PEW) evaporator or as an aqueous species. Volatile radionuclides, such as tritium and I-129, are not effectively removed during waste distillation in the PEW evaporator. Semivolatile nuclides, such as Ru-106, may be only partially removed. Therefore, an appreciable fraction of these volatile and semivolatile constituents can pass to the PEW condensate (overheads) that was sent to the injection well. The extent to which Tc-99 could have passed into the PEW condensate is unknown, because Tc-99 testing of the condensate or service waste was never performed. However, Thomas<sup>e</sup> has performed calculations of the volatility of Tc-99 under the conditions that would have existed in the PEW evaporator and in the Waste Calcining Facility. The results of these calculations show that the vapor pressure of dissolved technetium species in the PEW evaporator would be too low for a large amount of Tc-99 to pass over to the condensate. Nevertheless, there is evidence that Tc-99 is intermediate in terms of its volatility between volatile solutes, such as tritium and I-129, and essentially nonvolatile radionuclides, such as Sr-90 and Cs-137.

Even if the volatility of Tc-99 is too low to permit vapor-phase transport in the PEW evaporator, there still remains the possibility that some aqueous-phase Tc-99 could have entered the service waste sent to the injection well. Sr-90 is considered an essentially nonvolatile radionuclide, yet it has been estimated that 24.3 Ci of Sr-90 were disposed of to the injection well over its operational lifetime (DOE-ID 1997, Appendix F). The Sr-90 most likely entered the service waste in the aqueous phase, either as aerosol mists or in relatively small volumes of liquid decontamination wastes, and a much smaller amount of Tc-99 would likely have been present in the waste also. Another approach proposed by Swenson in Appendix G is based on the observation that the tritium:Tc-99 ratio in groundwater downgradient of the former injection well is approximately 100:1 in 2001 (Table 3-6). Because of the relatively short half-life of tritium, this ratio decreases with time and would have been larger in the past, perhaps in the range of 1,000:1 to 1,500:1 during the period when the injection well was in operation (1953–1986).<sup>a</sup> Assuming these ratios would have existed in the PEW condensate, the amount of Tc-99 sent to the disposal well can then be estimated. Based on the 21,300 Ci of tritium thought to have been disposed of to the injection well (DOE-ID 1997), this would suggest that perhaps 14 to 21 Ci of Tc-99 may have been sent to the injection well with the service waste.

Appendix G contains an evaluation by Swenson of the ratios of Tc-99, tritium, I-129, and nitrate observed in the groundwater at ICPP-MON-A-230 with these same ratios in the tank farm liquid wastes and in service waste sent to the former injection well. For relatively mobile constituents such as these, concentration ratios should remain fairly constant during subsurface transport (assuming the tritium activity has been adjusted for natural radioactive decay). The results of this analysis show that the contaminant ratios at ICPP-MON-A-230 resemble those in past releases at the tank farm (i.e., CPP-31, CPP-28 release sites).

Table 3-6 summarizes the calculated concentration ratios for the groundwater at ICPP-MON-A-230 and compares them with similar ratios calculated for average tank farm liquid waste and an average for groundwater from monitor wells located downgradient of the former injection well. As shown on this table, groundwater at ICPP-MON-A-230 has concentration ratios very similar to ratios in an average tank farm liquid waste. In contrast, contaminant ratios for other monitor wells downgradient of INTEC are very different than those in either the tank farm liquid waste or groundwater at ICPP-MON-A-230. The other downgradient wells have chemical signatures representative of the service waste that was previously sent to the former injection well. This analysis provides strong geochemical evidence that the elevated

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e. Thomas, T. R., INEEL, to M. C. Swenson, INEEL, October 20, 2003, "Volatility of technetium from process evaporator and calciner operations."

Table 3-6. Comparison of contaminants in groundwater and tank farm waste.

Ratio	ICPP-MON-A-230	Average Tank Farm Release <sup>a</sup>	Groundwater Downgradient of INTEC <sup>b</sup>
H-3/Tc-99	1.7	2.2	100
NO <sub>3</sub> /H-3 (g/μCi)	8.1	4.7	0.1
NO <sub>3</sub> /Tc-99 (g/μCi)	14	10	100

a. Average composition of CPP-28 and CPP-31 releases.  
b. Rounded average value based on 2001 and 2003 results for monitor wells USGS-42, -48, -57, -67, and -123.

Tc 99 concentration currently present at ICPP-MON-A-230 is derived from past liquid releases at the tank farm, not from service waste discharges to the former injection well.

### 3.10 Tc-99 Results for Archived Groundwater Samples

Groundwater samples from the INTEC area were not analyzed for Tc-99 prior to the first sampling for this radionuclide performed by the USGS in 1991-92 (Beasley et al. 1998). However, each year beginning in 1968, the USGS has set aside an extra 1-L groundwater sample from each of the USGS monitor wells and water supply wells that are sampled during their spring sampling event. The extra water samples are stored (archived) indefinitely at CFA in order to permit future testing of groundwater using improved laboratory methods or in case unanticipated questions should arise regarding past concentrations of chemical constituents in groundwater. After the May 2003 sample from monitor well ICPP-MON-A-230 was found to exceed the Tc-99 MCL, questions arose regarding past concentrations of Tc-99 in the aquifer. A discussion with USGS staff indicated that some of their archived groundwater samples could be made available for analysis of Tc-99. Clearly, laboratory results for water samples that have been stored for 20+ years should be used with caution, as standard holding times and other quality assurance/quality control requirements have not been met. In addition, some of the archived water samples had been preserved with hydrochloric acid, while others had not. In spite of these variables, the consensus of the project team was that Tc-99 results for archived water samples ought to be valid because the pertechnetate anion remains stable in groundwater, with little or no tendency to precipitate, adsorb, or volatilize. Therefore, the decision was made to proceed with Tc-99 testing of the archived water samples, with the caveat that the results should be used for information and screening purposes only and are not intended for making decisions under CERCLA.

Groundwater samples collected by the USGS from selected wells between 1970 and 1990 were analyzed for Tc-99 by the Radiological and Environmental Sciences Laboratory located at CFA. Four wells were selected and, for each well, groundwater samples collected in 1970, 1975, 1980, 1985, and 1990 were tested. Samples tested were those from wells located closest to the INTEC tank farm and/or former injection well.

Table 3-7 summarizes the Tc-99 results for the archived water samples, along with the available Tc-99 results for these same wells reported for routine (nonarchived) groundwater samples collected after 1990. Figure 3-12 shows the results as time-series trend plots. The highest Tc-99 concentration reported for any of the archived water samples was  $121 \pm 9$  pCi/L for the sample collected from deep perched monitor well USGS-50 on April 18, 1975. Water quality in USGS-50 was significantly impacted by the failure of the INTEC injection well during 1968-71, which allowed service waste to be temporarily discharged into the deep vadose zone (DOE-ID 2004a), as well as direct injection of service waste into USGS-50 during September-October 1971 (Amberson 1971).

Table 3-7. Summary of Tc-99 results for selected wells.

Well	Sample Date	Tc-99 (pCi/L)	Total Uncertainty (pCi/L)	Preservative	Sample Type
CPP-1	01/29/70	35	6	Raw	Pump
CPP-1	07/30/75	7	5	2% HCl	Pump
CPP-1	04/15/80	-3	5	2% HCl	Unknown
CPP-1	07/11/85	3	5	Raw	Pump
CPP-1	04/17/90	-10	5	Raw	Pump
CPP-1	06/05/95	31	1		Pump
CPP-1	10/22/02	23.6	2.35		Pump
CPP-1	10/02/03	44.7	3.09	HNO3	Pump
CPP-1	10/13/03	26.3	2.1	HNO3	Pump
USGS-47	04/21/70	-7	5	2% HCl	Thief
USGS-47	07/29/75	-8	5	2% HCl	Thief
USGS-47	04/15/80	-6	5	2% HCl	Unknown
USGS-47	04/23/85	4	5	Raw	Thief
USGS-47	04/17/90	7	5	Raw	Unknown
USGS-47	06/26/95	174	2		
USGS-47	10/20/99	1.63	0.283		
USGS-47	04/25/01	38.3	2.78	HNO3	Pump
USGS-47	04/10/03	42.5	2.52	HNO3	Pump
USGS-50	04/21/70	7	5	2% HCl	Thief
USGS-50	04/18/75	121	9	2% HCl	Thief
USGS-50	02/20/81	57	7	2% HCl	Unknown
USGS-50	04/23/85	-2	5	Raw	Bailer
USGS-50	04/23/90	43	6	Raw	Unknown
USGS-50	01/01/92	55.6	0.43		
USGS-50	12/14/1993	71	1		
USGS-50	12/16/1994	77	1		
USGS-50	5/30/1995	75	1		
USGS-50	2/26/2001	50.2	3.19		
USGS-52	10/17/70	61	7	Raw	Thief
USGS-52	04/15/75	33	6	2% HCl	Thief
USGS-52	04/22/80	85	8	2% HCl	Unknown
USGS-52	04/23/85	65	7	Raw	Thief
USGS-52	04/03/90	91	8	Raw	Unknown
USGS-52	05/12/95	235	3		
USGS-52	04/25/01	322	6.6	HNO3	Pump
USGS-52	04/14/03	313	6.77	HNO3	Pump

Note: Gray shaded cells are for archived water samples; all others are conventional groundwater samples.

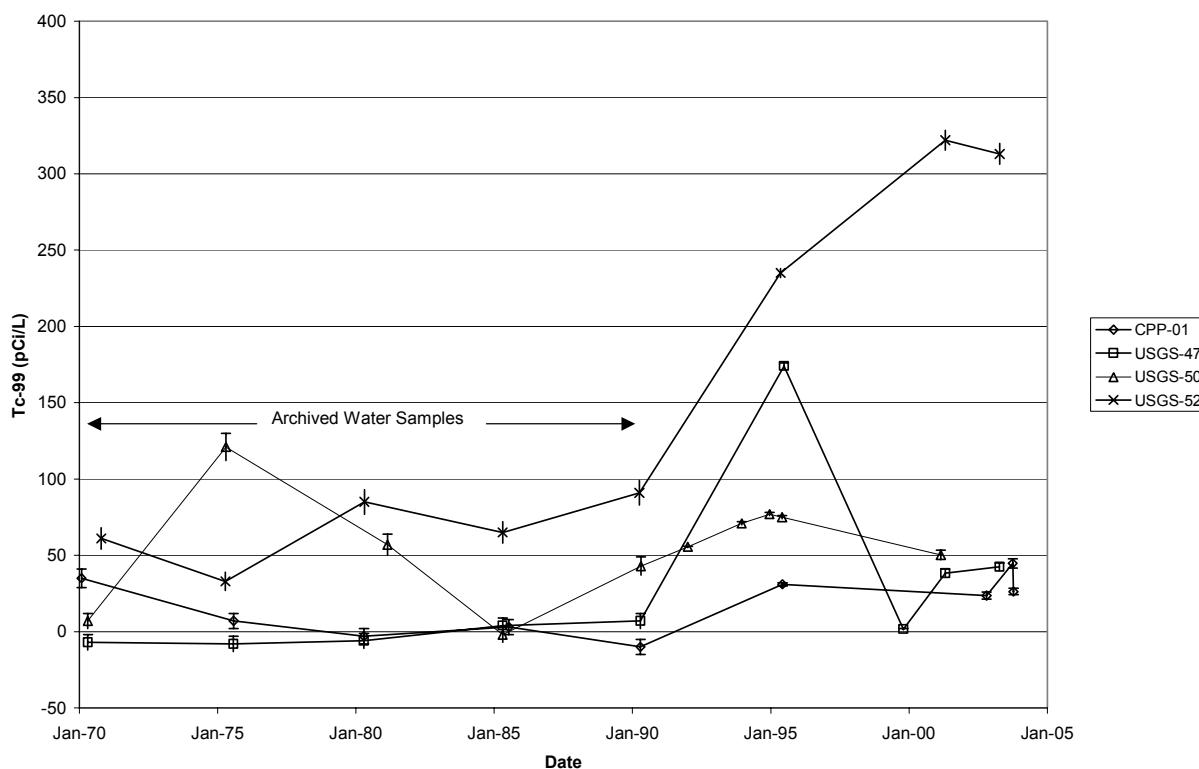


Figure 3-12. Tc-99 results for groundwater samples from selected wells.

Another significant observation is that the results for the archived water testing indicate that Tc-99 was present in 1970 in INTEC water supply well CPP-01 at a concentration of  $35 \pm 6$  pCi/L. This coincides with the time period when groundwater quality at CPP-01 was impacted by the injection well failure (Amberson 1972a, b).

The results for monitor well USGS-52 show a significant increase in Tc-99 concentrations beginning in about 1990 (Figure 3-12). A similar rising trend for Tc-99 has been observed in USGS-112 located roughly halfway between INTEC and CFA, but the increase in that well appears to begin in about 2000 (DOE-ID 2003a). The increasing concentrations of Tc-99 observed in these wells contrasts with the declining concentrations of tritium, Sr-90, and I-129 in the aquifer (DOE-ID 2004a).



## **4. CONCLUSIONS AND RECOMMENDATIONS**

The following conclusions are based on the results of the Phase 1 investigation of Tc-99 at INTEC:

- Groundwater at ICPP-MON-A-230 contains Tc-99 at concentrations between 2,000 and 3,000 pCi/L. This is the only location at INTEC where the observed Tc-99 concentration has exceeded the derived MCL of 900 pCi/L (including perched monitor wells and vadose zone water from suction lysimeters in and around the tank farm).
- Monitoring results for raw water well CPP-01 show that low concentrations of Tc-99 were present in the aquifer at this location by 1995, 6 years before installation of the Tank Farm Well Set. Results for archived groundwater samples suggest that Tc-99 may have been present in CPP-01 even earlier, perhaps as early as 1970.
- ICPP-MON-A-230 is constructed in a manner that minimizes the possibility of downhole migration of contaminated water, and it is concluded that the occurrence of Tc-99 in the aquifer cannot be attributed to installation of this well or other monitor wells at the Tank Farm Well Set.
- The pumping test confirms that the aquifer is very permeable at the location of ICPP-MON-A-230, with hydraulic conductivities in the range of 2,000 to 4,000 ft/day.
- The persistence of Tc-99 concentrations exceeding 2,000 pCi/L during the 5-hour pumping test indicates that the Tc-99 is present over a volume of the aquifer that extends at least 35 ft radially from monitor well ICPP-MON-A-230.
- At several times in the past when the injection well was in operation, the capture zone of the INTEC raw water wells CPP-01 and -02 extended at least as far south as the injection well and almost certainly included some portion of the aquifer underlying the tank farm.
- The evidence strongly suggests that the source of the elevated Tc-99 activity in the groundwater near ICPP-MON-A-230 is historical liquid waste releases at the tank farm, in particular the Site CPP-31 and CPP-28 releases. This observation represents possible evidence of groundwater quality impact from releases associated with the tank farm (OU 3-14).
- The most likely mechanism for transport of Tc-99 from contaminated soils at the tank farm to the aquifer is downward movement of contaminated water through the vadose zone to the water table.
- Alternating layers of basalt and sedimentary interbeds present beneath the tank farm area may result in significant horizontal flow of water percolating downward towards the aquifer.
- The former INTEC injection well likely constituted an earlier source of Tc-99 to the aquifer, but the resulting groundwater concentrations did not exceed the MCL. The dilute Tc-99 plume that extends south and downgradient of INTEC is most likely primarily the result of service waste discharges to the former injection well, not contaminated soils at the tank farm.

Based on discussions with the Agencies and the project team, it is recommended that a work plan be developed for a Phase 2 investigation of Tc-99 to further delineate the nature and extent of Tc-99 in the perched water and aquifer beneath the northern portion of INTEC. The Phase 2 investigation should be performed as a continuation of the OU 3-13 Group 4 Phase 1 well installation activities. The primary

task recommended for Phase 2 is the installation of two new well sets along the southern boundary of the tank farm. Figure 4-1 shows the proposed locations of the two well sets. These are the same locations where additional monitor wells were previously proposed for installation in the MWTS (DOE-ID 2003b), but the decision to install the wells had been deferred. Each well set should include a shallow perched monitor well, a deep perched well, and an aquifer skimmer well. The new well sets should be incorporated into the existing Group 4 annual monitoring program.

The proposed schedule for the Phase 2 investigation of Tc-99 at INTEC is to prepare the drilling bid package during FY-04, then perform drilling and monitor well installation during FY-05. This schedule will then permit revision of the WAG 3 vadose zone transport model during FY 2006–2007, and submission of the Group 4 Monitoring Report/Decision Summary in February 2008, as currently scheduled.

The observed Tc-99 concentration at ICPP-MON-A-230 significantly exceeded the predicted concentration from both the original OU 3-13 RI/BRA contaminant transport model (DOE-ID 1997) and the more recent updated WAG 3, Group 5 model (DOE-ID 2003b). The INTEC vadose zone model will be revised to reflect the new Tc-99 information. The model revision is currently being performed as part of the OU 3-14 Preliminary Baseline Risk Assessment.

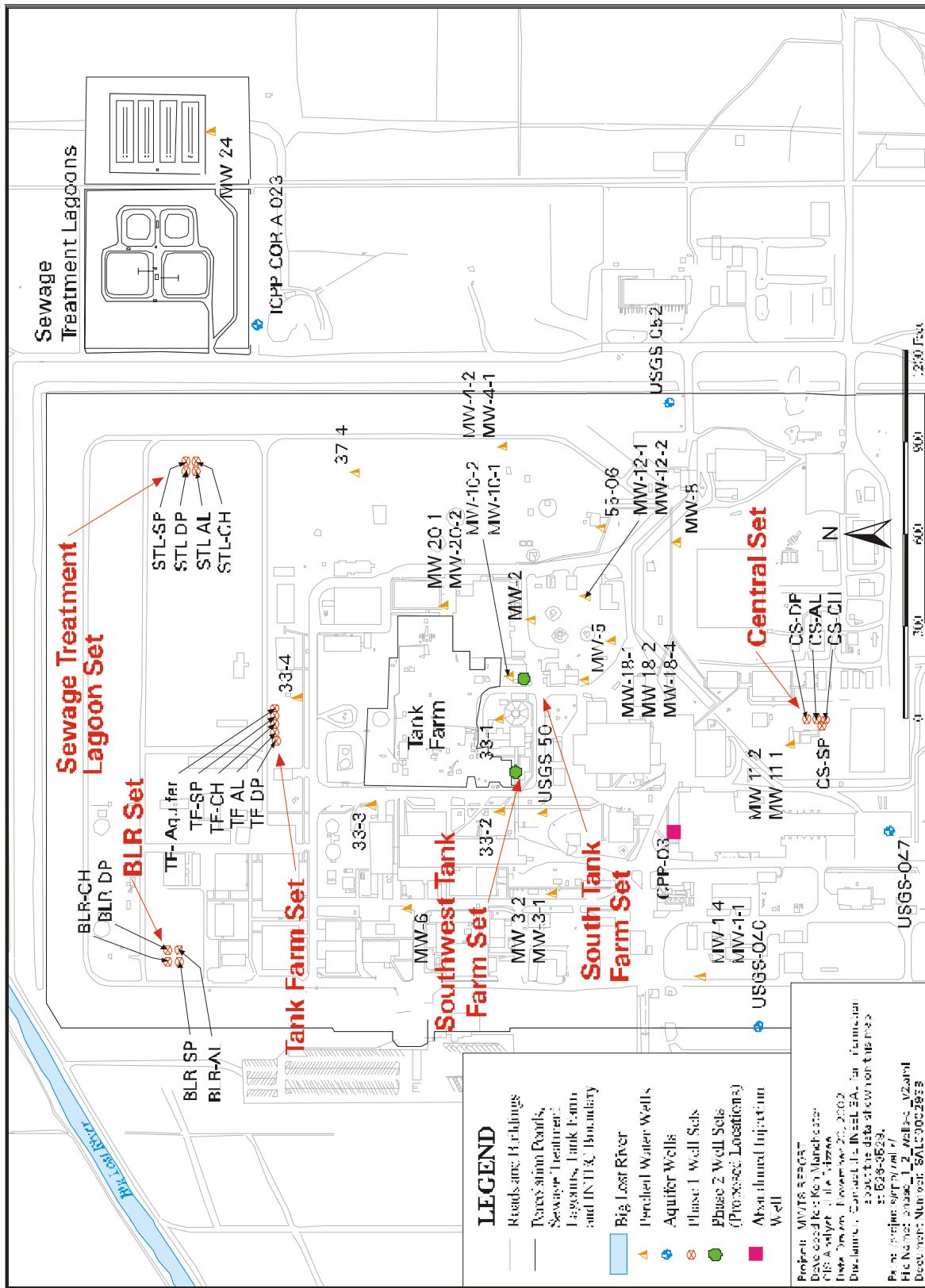


Figure 4-1. Proposed Phase 2 monitor well locations.



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## **Appendix A**

### **Water Quality Results for Monitor Well ICPP-MON-A-230**



**Water Quality Field Parameters for Pumping Test at  
ICPP-MON-A-230 October 30, 2003**

Time	Temperature (°C)	pH	Electrical Conductivity (μmhos/cm)	D.O. (mg/L)	D.O. (% SAT.)	Oxidation Reduction Potential (mV)
1045	0.31	7.61	671	10.28	77.3	+95
1046	2.77	7.59	631	5.18	46.4	+97
1047	5.26	7.61	614	4.95	47.2	+98
1151	7.36	7.63	665	7.57	79.1	+111
1152	9.57	7.71	666	7.31	78.5	+113
1153	10.50	7.71	665	7.35	79.6	+114
1248	10.92	7.63	663	7.63	83.1	+139
1249	11.22	7.67	661	7.33	80.8	+139
1250	11.39	7.66	661	7.20	79.9	+139
1346	10.51	7.66	667	7.70	84.1	+142
1347	11.23	7.69	665	7.50	82.9	+142
1348	11.30	7.69	664	7.36	81.5	+142
1446	10.24	7.63	668	7.96	86.5	+86
1447	10.95	7.70	666	7.73	85	+85
1448	11.24	7.69	665	7.65	84.7	+84

Field Sample Number	Lab Sample Number	SDG Number	TOSISOW Number	COC Number	Lab Code	Type of Location	Location	Depth	Compound	Sample Result	Sample Units	Date Sample Collected	MDA	L&V Report Number
<b>Radionuclides</b>														
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Americium-241	-0.006	0.004	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Americium-241	0.006	0.013	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Americium-241	0.019	0.019	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Antimony-125	0.219	2.62	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Antimony-125	2.94	3.28	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Antimony-125	-3.79	3.93	U	PC/L	01/13/2003
50M12502CW	80829002	50M12501CW	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Carbon-14	0.686	0.899	U	PC/L	05/13/2003
50M12501CW	80829001	50M12501CW	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Carbon-14	1.27	1.12	U	PC/L	05/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cerium-144	-4.75	7.07	U	PC/L	05/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cerium-144	-0.373	7.38	U	PC/L	01/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cerium-144	8.41	9.76	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-134	-1.48	1.13	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-134	-1.69	1.49	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-134	-0.453	1.71	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-137	0.531	0.955	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-137	-0.538	1.40	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cesium-137	8.20	5.94	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cobalt-60	-2.61	1.22	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cobalt-60	0.826	1.19	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cobalt-60	-0.288	1.49	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-152	-0.324	2.79	U	PC/L	05/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-152	7.70	3.89	U	PC/L	01/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-152	0.715	4.00	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-154	3.19	2.50	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-154	9.07	3.64	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-154	-3.41	3.70	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-155	-3.12	4.07	U	PC/L	05/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-155	-4.99	4.41	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Europium-155	-0.982	5.46	U	PC/L	05/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Alpha	32.7	2.72	J	PC/L	05/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Alpha	61.5	3.95	R	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Alpha	92	5.66	R	PC/L	01/13/2003
50M13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Beta	931	19.1	J	PC/L	05/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Beta	1120	7.46	J	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Gross Beta	1220	9.30	J	PC/L	01/13/2003
50M11001UD	80759001	50M11001UD	19643	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.117	0.026	J	PC/L	05/13/2003
50M13802RH	100014004	50M13801RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.076	0.042	U	PC/L	01/13/2003
50M11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.030	0.051	U	PC/L	01/13/2003
50M13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.047	0.027	U	PC/L	01/13/2003
50M11001UD	80759001	50M11001UD	19643	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.156	0.061	J	PC/L	05/13/2003
50M13801RH	100528001	50M13801RN	22369	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.132	0.039	U	PC/L	12/16/2003
50M11001RH	80759002	50M13801RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iodine-129	0.153	0.061	U	PC/L	12/16/2003
50M32301RN	101829002													

Field Sample Number	Lab Sample Number	TOSISOW Number	COC Number	Lab Code	Type of Location	Location	Depth	Compound	Sample Result	Sample Units	Date Sample Collected	MDA	L&V Report Number
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Plutonium-239/240	-0.024	0.009	U	PC/L 0/13/2003 1.17E-01 SOS-TL260-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Plutonium-239/240	0.078	0.037	U	PC/L 0/13/2003 1.26E-01 SOS-TL260-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Plutonium-241	-0.279	1.68	U	PC/L 0/13/2003 5.67E+00 SOS-TL136-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Plutonium-241	-2.27	2.77	U	PC/L 0/13/2003 9.48E+00 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Plutonium-241	-2.69	3.02	U	PC/L 0/13/2003 1.04E+01 SOS-TL260-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Radium-226	0.342	0.171	U	PC/L 0/13/2003 5.38E-01 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Radium-226	0.88	0.244	U	PC/L 0/13/2003 6.20E-01 SOS-TL260-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Radium-228	-0.258	0.202	U	PC/L 0/13/2003 6.91E-01 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Radium-228	-0.095	0.232	U	PC/L 0/13/2003 7.88E-01 SOS-TL260-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Ruthenium-106	-7.58	8.02	U	PC/L 0/13/2003 2.78E+01 SOS-TL136-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Ruthenium-106	-17.80	11.2	U	PC/L 0/13/2003 3.58E+01 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Ruthenium-106	9.75	13.5	U	PC/L 0/13/2003 5.16E+01 SOS-TL260-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-108m	-0.882	0.985	U	PC/L 0/13/2003 3.27E+00 SOS-TL136-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-108m	-1.39	1.22	U	PC/L 0/13/2003 4.13E+00 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-108m	-1.08	1.39	U	PC/L 0/13/2003 4.60E+00 SOS-TL260-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-110m	-0.404	0.873	U	PC/L 0/13/2003 3.10E+00 SOS-TL136-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-110m	-0.109	1.34	U	PC/L 0/13/2003 4.81E+00 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver-110m	1.33	1.44	U	PC/L 0/13/2003 5.59E+00 SOS-TL260-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.61	1.05	U	PC/L 0/13/2003 7.55E-01 SOS-TL136-03
5OM13802RH	100014004	5OM15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.06	1.06	U	PC/L 0/13/2003 6.83E-01 SOS-TL260-03
5OM13801RH	100014005	5OM15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.76	1.09	U	PC/L 0/13/2003 7.85E-01 SOS-TL260-03
5OM16101RH	101184008	5OM17301RH	23621	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.16	1.14	U	PC/L 0/28/2003 1.07E+00 SOS-TL006-04
5OM16301RH	101184004	5OM17301RH	23621	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.31	1.37	U	PC/L 0/28/2003 1.17E+00 SOS-TL006-04
5OM17401RH	101184009	5OM17301RH	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.38	1.03	U	PC/L 0/30/2003 1.08E+00 SOS-TL006-04
5OM17501RH	101184010	5OM17301RH	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.06	1.06	U	PC/L 0/30/2003 1.13E+00 SOS-TL006-04
5OM17601RH	101184011	5OM17301RH	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.64	1.11	U	PC/L 0/30/2003 1.07E+00 SOS-TL006-04
5OM17702RH	101184012	5OM17301RH	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.26	1.20	U	PC/L 0/30/2003 1.05E+00 SOS-TL006-04
5OM17801RH	101184013	5OM17301RH	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.61	1.25	U	PC/L 0/30/2003 1.35E+00 SOS-TL006-04
5OM17301RH	101184001	5OM17301RH	23621	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	8.83	1.31	U	PC/L 0/30/2003 1.31E+00 SOS-TL006-04
5OM17701RH	101184005	5OM17301RH	23621	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	9.50	1.36	U	PC/L 0/30/2003 1.25E+00 SOS-TL006-04
5OM32302RH	101821002	5OM32301RH	19731	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	6.32	0.825	U	PC/L 1/12/2003 5.41E-01 BAM-008-04
5OM32301RH	101821001	5OM32301RH	19731	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	6.30	0.851	U	PC/L 1/12/2003 5.99E-01 BAM-008-04
5OM19601RB	104226016	5OM19601RN	23693	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	6.57	0.879	U	PC/L 1/16/2003 5.88E-01 SOS-TL039-04
5OM19602RB	104226017	5OM19601RN	23693	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.69	1.05	U	PC/L 1/16/2003 5.53E-01 SOS-TL039-04
5OM28202RH	105049007	5OM28202RN	24303	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	6.53	0.909	U	PC/L 0/10/2004 5.91E-01 BAM-87-03
5OM28201RH	105049006	5OM28202RN	24303	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Strontrium-90	7.84	1.03	U	PC/L 0/10/2004 6.64E-01 BAM-87-03
5OM11001RH(RE)	85255001	5OM11001RH	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Technetium-99	2110	32.4	U	PC/L 0/5/13/2003 6.75E+00 BAM-84-03
5OM11001RH	80759002	5OM11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Technetium-99	2220	37.7	U	PC/L 0/5/13/2003 1.60E+01 SOS-TL136-03
5OM12702EA	85882004	5OM12601EA	16469	ER-TOS-A2155	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Technetium-99	2770	42.2	U	PC/L 0/8/11/2003 7.94E+00 BAM-87-03
5OM12701EA	8893001	5OM13601EA	22324	ER-TOS-A2155	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Technetium-99	2840	43.4	U	PC/L 0/8/11/2003 8.18E+00 BAM-87-03
5OM13102EA	F3H120241-004	5OM13001EA	20239	ER-TOS-A2157	STL-STLLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Technetium-99	2000	200	U	PC/L 0/8/11/2003 1

Field Sample Number	Lab Sample Number	TOSISOW Number	COC Number	TOSISOW Number	Lab Code	Type of Location	Location	Depth	Compound	Sample Result	Sample Units	Date Sample Collected	MDA	L&V Report Number
5OM32302RH	101821002	5OM32301RH	19731	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2120	36.9	1/12/2003	1.62E+01	BAM-008-04
5OM32301RH	101821001	5OM32301RH	19731	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2420	42.0	1/12/2003	1.68E+01	BAM-008-04
5OM19501EA	104226010	5OM19601RN	23693	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2640	46.0	1/16/2003	1.58E+01	SOS-TL039-04
5OM19502EA	104226011	5OM19601RN	23693	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2720	47.5	1/16/2003	1.65E+01	SOS-TL039-04
5OM28202RH	105049007	5OM28202RN	24303	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2790	41.6	1/07/2004	7.56E+00	
5OM28201RH	105049006	5OM28202RN	24303	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Techneium-99	2780	41.9	1/07/2004	7.30E+00	
5OM13802RN	100528002	5OM13801RN	22394	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5140	172	1/13/2003	3.54E+02	SOS-033-03
5OM13801RN	100528001	5OM13801RN	22393	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5540	182	1/13/2003	3.71E+02	SOS-033-03
5OM16201R8	101193003	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5180	205	1/28/2003	2.51E+02	SOS-TL009-04
5OM16202R8	101193004	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5490	210			
5OM16301R8	101193005	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5530	214			
5OM16101R8	101193002	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5520	218			
5OM17501R8	101193009	5OM17101R8	23623	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5190	206			
5OM17702R8	101193012	5OM17101R8	23623	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5280	207			
5OM17801R8	101193013	5OM17101R8	23623	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5480	207			
5OM17601R8	101193010	5OM17101R8	23623	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5210	208			
5OM17301R8	101193007	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-448	Tritium	5130	212			
5OM17701R8	101193011	5OM17101R8	23623	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	5680	212			
5OM17401R8	101193008	5OM17101R8	23622	ER-TOS-A2210	GEL	MONITORING WELL	ICPP-MON-A-230	443-448	Tritium	5710	217			
5OM32302RN	101829003	5OM32401RN	23653	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4940	213			
5OM32301RN	101829002	5OM32401RN	23653	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4870	215			
5OM19502RN	104226003	5OM19601RN	24301	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4640	253			
5OM19501RN	104226002	5OM19601RN	24301	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4780	260			
5OM28202RN	105049001	5OM32301RN	24302	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4760	236			
5OM28201RN	105049002	5OM28202RN	24302	ER-TOS-A2229	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	4860	242			
5OM11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-233/234	1.91	0.218	1/13/2003	8.77E-02	SOS-TL136-03
5OM13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-233/234	1.88	0.205	1/13/2003	6.04E-02	SOS-TL260-03
5OM13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-233/234	1.83	0.206	1/13/2003	7.95E-02	SOS-TL260-03
5OM11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-235	0.189	0.051	1/13/2003	3.78E-02	SOS-TL136-03
5OM13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-235	0.037	0.020	1/13/2003	5.14E-02	SOS-TL260-03
5OM13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-235	0.206	0.050	1/13/2003	6.56E-02	SOS-TL260-03
5OM11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-238	1.0	0.138	1/13/2003	3.76E-02	SOS-TL136-03
5OM13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-238	1.33	0.157	1/13/2003	2.91E-02	SOS-TL260-03
5OM13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Uranium-238	1.32	0.161	1/13/2003	5.56E-02	SOS-TL260-03
5OM11001RH	80759002	50M11001UD	19645	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Zinc-65	-2.98	2.19	U	7.47E+00	SOS-TL136-03
5OM13802RH	100014004	50M15501RH	22366	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Zinc-65	-3.33	2.45	U	8.37E+00	SOS-TL260-03
5OM13801RH	100014005	50M15501RH	22367	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Zinc-65	6.53	3.06	U	1.36E+01	SOS-TL260-03
<b>Inorganics</b>														
50M12501A1	80579003	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Alkalinity, Total as CaCO <sub>3</sub>	135		1/13/2003	DNT-155-03	
50M12502A1	80579004	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Alkalinity, Total as CaCO <sub>3</sub>	136		1/13/2003	DNT-155-03	
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Aluminum	118		1/13/2003	DNT-135-03	
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Aluminum	171		1/13/2003	DNT-135-03	
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Antimony	3.46		1/13/2003	DNT-135-03	
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Antimony	3.46		1/13/2003	DNT-135-03	
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Arsenic	3.31		1/13/		

Field Sample Number	Lab Sample Number	TOSISOW Number	COC Number	Lab Code	Type of Location	Location	Depth	Compound	Sample Result	Sample Error	Validation Flag	Sample Units	Date Sample Collected	MDA	L&V Report Number
50M12501AN	80579001	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Chloride	64.4		mg/L	05/13/2003		DNT-155-03
50M12502AN	80579002	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Chloride	65.6		mg/L	05/13/2003		DNT-155-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Chromium	11.3		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Chromium	12.7		ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cobalt	1.01	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Cobalt	1.01	U	ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Copper	18.0	B	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Copper	18.4	B	ug/L	05/13/2003		DNT-135-03
50M12501AN	80579001	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Fluoride	0.296	J	mg/L	05/13/2003		DNT-155-03
50M12502AN	80579002	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Fluoride	0.293	J	mg/L	05/13/2003		DNT-155-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iron	351		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Iron	391		ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Lead	2.40	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Lead	2.40	U	ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Magnesium	20100		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Magnesium	20300		ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Manganese	19.8		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Manganese	19.6		ug/L	05/13/2003		DNT-135-03
50M11001HG	80854002	50M09001HG	19650	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Mercury	0.095	U	ug/L	05/13/2003		DNT-150-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Mercury	0.095	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Mercury	0.095	U	ug/L	05/13/2003		DNT-135-03
50M13802HZ	100526002	50M13801HZ	22391	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Mercury	0.033	U	ug/L	01/13/2003		DNT-272-03
50M13801HZ	100526001	50M13801HZ	22391	ER-TOS-A2205	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Mercury	0.033	U	ug/L	01/13/2003		DNT-272-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Nickel	28.1	B	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Nickel	27.6	B	ug/L	05/13/2003		DNT-135-03
50M12701N2	85881002	50M12601N2	16469	ER-TOS-A2155	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Nitrogen, Nitrate/Nitrite	9.10		ug/L	08/11/2003		DNT-183-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Potassium	4420		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Potassium	4480		ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Selenium	3.39	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Selenium	3.39	U	ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver	1.70	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Silver	1.70	U	ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Sodium	28900		ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Sodium	29600		ug/L	05/13/2003		DNT-135-03
50M12501AN	80579001	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Sulfate	46.6	J	mg/L	05/13/2003		DNT-155-03
50M12502AN	80579002	50M12501AN	19640	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Sulfate	47.2	J	mg/L	05/13/2003		DNT-155-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Thallium	3.64	U	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Thallium	3.64	U	ug/L	05/13/2003		DNT-135-03
50M11001R8	80759005	50M11001UD	19650	ER-TOS-A2075	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Tritium	3700	178		SOS-TL136-03	3.26E+02	
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Vanadium	3.61	B	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Vanadium	3.49	B	ug/L	05/13/2003		DNT-135-03
50M12501LM	80830001	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Zinc	7.90	B	ug/L	05/13/2003		DNT-135-03
50M12502LM	80830002	50M12501LM	19649	ER-TOS-A2023	GEL	MONITORING WELL	ICPP-MON-A-230	443-483	Zinc	9.90	B	ug/L	05/13/2003		DNT-135-03





Semivolatile Organic Compounds

5CM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4,5-Tetrachlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4,5-Tetrachlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4,5-Tetrachlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5CM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4-Trichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4-Trichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,4-Trichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5CM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2-Dichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2-Dichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2-Dichlorobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5CM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,2,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5CM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,3,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,3,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	1,3,5-Trinitrobenzene	10	U	UG/L	10/13/2003	DMG-147-03













Field Sample Number	Lab Sample Number	TOSISOW Number	COC Number	TOSISOW Number	Lab Code	Type of Location	Location	Depth	Compound	Sample Result	Sample Units	Date Sample Collected	MDA	L&V Report Number
5OM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pronamide	10	U	1/13/2003		DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pronamide	10	U	1/13/2003		DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pronamide	10	U	1/13/2003		DMG-147-03
5OM13801X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyrene	10	U	1/13/2003		DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyrene	10	U	1/13/2003		DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyrene	10	U	1/13/2003		DMG-147-03
5OM13801X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyridine	10	U	1/13/2003		DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyridine	10	U	1/13/2003		DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Pyridine	10	U	1/13/2003		DMG-147-03
5OM138011X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Safrole	10	U	1/13/2003		DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Safrole	10	U	1/13/2003		DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Safrole	10	U	1/13/2003		DMG-147-03
5OM13801X	F3J160346001	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Sulfotep	40	U	1/13/2003		DMG-147-03
5OM13801HN	F3J160346002	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Sulfotep	40	U	1/13/2003		DMG-147-03
5OM13802HN	F3J160346003	5OM138011X	22382	ER-TOS-A2206	STL-STLOUIS	MONITORING WELL	ICPP-MON-A-230	443-483	Sulfotep	40	U	1/13/2003		DMG-147-03

a. "J" flags (estimated value) were assigned because Laboratory Control Standard (LCS) was outside control limits due to high percent recovery.

Validation Flags:

J = estimated value.

U = nondetect.

R = rejected.



## **Appendix B**

### **Hydrograph and Neutron Log for Monitor Well ICPP-MON-A-230**



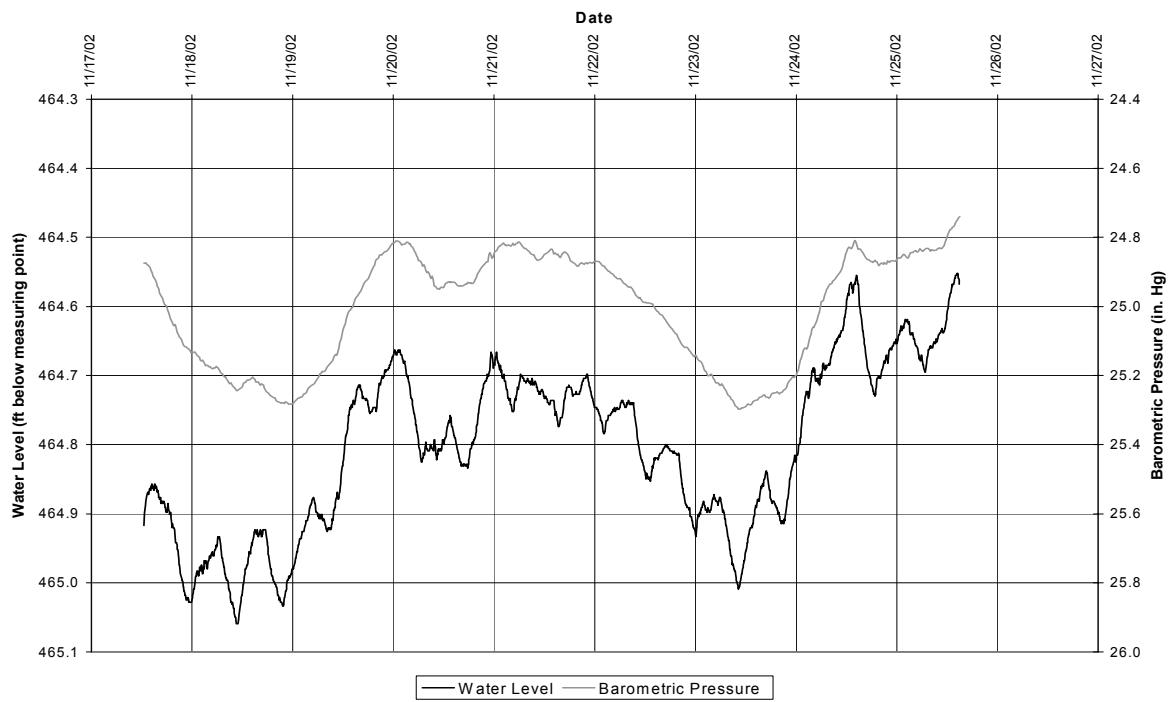
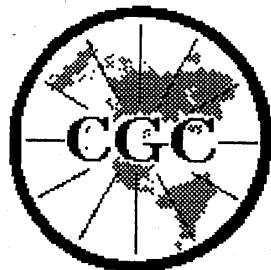


Figure B-1. Hydrograph for ICPP-MON-A-230.



Neutron log interpretation by Brian Twining - USGS

*Century*  
GEOPHYSICAL CORP.

ICPP-MON-A-230 ← Tank Farm Aquifer Well

COMPANY	:	USGS	OTHER SERVICES:
WELL	:	ICPP-MON-A-230	none
LOCATION/FIELD	:	INTEC	
COUNTY	:	Butte	
STATE	:	ID	
SECTION	:	None	TOWNSHIP : None
			RANGE : None
DATE	:	10/23/03	PERMANENT DATUM : None
DEPTH DRILLER	:	493	KB : None
LOG BOTTOM	:	478.75	DF : None
LOG TOP	:	0.50	GL : None
CASING DIAMETER	:	6	LOGGING UNIT : USGS
CASING TYPE	:	Steel	FIELD OFFICE : None
CASING THICKNESS	:	.25	RECORDED BY : MJG,MSV
BIT SIZE	:	6	BOREHOLE FLUID : 0
MAGNETIC DECL.	:	0	RM : 0
MATRIX DENSITY	:	2.71	RM TEMPERATURE : 0
NEUTRON MATRIX	:	Dolomite	MATRIX DELTA T : 54
			FILE : ORIGINAL
			TYPE : 9057A
			THRESH: 2500

source lo

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